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Interdisciplinary Investigations in Support of Project DI-MOD

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NASA Ames Research Center
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Moffett Field, CA 94035

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1. Background

In September 1990, a research grant was awarded to The University of Texas at El Paso (U.T. El Paso) by the National Aeronautics and Space Administration (NASA). The purpose of the grant was to enlist the services of the university in support of Project DI-MOD. Under the proposed research agreement, researchers from U.T. El Paso will :

(1) investigate potential extensions of Project DI-MOD to additional sites in Central America,

(2) research human migration patterns and their impact on malaria transmission,

(3) and perform an investigation into possible computer-based approaches to the analysis of remotely sensed multispectral data.

This report serves to cover the activities conducted by U.T. El Paso in support of these goals during the six-month period from September 1990 to April 1991.

2. Approach

During the past six months, the major thrust of the U.T. El Paso effort was directed at the evaluation of potential test sites in the Central American country of Belize. During this period, the U.T. El Paso team conducted a somewhat thorough literature investigation of Belize to determine its suitability to support a remote sensing based modeling and prediction program for malaria. In addition, a team of researchers consisting of Drs. Cheryl Howard (Sociology), Lillian Mayberry (Biological Sciences), Scott Starks (Electrical Engineering), and Robert Tonn (Biological Sciences) traveled to Belize to collect data and statistics, meet key Belizean personnel, survey the countryside, and ascertain first-hand the viability of extending Project DI-MOD to Belize. A report was prepared relating to this activity and was presented to NASA in March 1991. The main body of this report is included in Appendix I. A summary of findings and conclusions relating to this activity is included in Section 3 of this report.

In November 1990, the principal investigator, Dr. Scott Starks, traveled to Fresno, California to participate in the Project DI-MOD Investigators' Working Group Meeting. At this meeting, planned activities to be conducted by U.T. El Paso were presented and reviewed.

There has as yet been no decision made concerning the selection of the Phase III test site. As a consequence, field trips to support investigations into human migration have yet to been organized and scheduled.

At the current time, the U.T. El Paso team is making progress on the investigation of sensor fusion techniques for multi-

dimensional data. A graduate student has been selected to assist the project and a search of the literature related to sensor fusion has been conducted.

3. Summary of Belize Findings

A team from the University of Texas at El Paso visited Belize from 3 to 10 January 1991 to study the potential of that country as a site to conduct Phase III of the NASA DI-MOD project. The first phase of the project was done in the central valley of California and demonstrated that it was possible to predict changes in mosquito populations using remote sensing and radar. Furthermore it showed that certain rice fields in the area produced more mosquitos than other fields. A combination of pinpointing areas of greater mosquito production and monitoring changes in mosquito larval densities in areas could increase the effectiveness of malaria control and reduce cost considerably. Because of the success in California, Phase II was begun along the southern Pacific coast of Mexico near Tapachula. The major vectors of this area are Anopheles albimanus and An. pseudopunctipennis. Field studies have shown certain habitats produce most of the mosquitos and the dominant vegetation associated with each has been identified.

Previously the U.T. El Paso team visited Costa Rica and found that an area in Guanacaste might serve as a potential site for Phase III. There is a large on-going irrigation project and environmental assessment studies are in progress. However, NASA suggested that before a final selection was made, at least one additional country should be studied and suggested Belize.

The team consisted of an electrical engineer, a sociologist/demographer, a parasitologist, and an entomologist. The team visited two possible districts of Belize in which the National Malaria Service encounters the greatest problem with malaria. These were along the Western Highway in Cayo district between Belmopan and the Guatemalan border and near Punta Gorda in the southern district of Toledo. The team met with staff from the Ministry of Health concerning malaria, the National Meteorological Service for rainfall and temperature data, the Refugee Service for information on refugee settlements and immigration, and the Central Statistics Office for general information about the country. To determine potential human resources, the team met with staff from the Belize Agricultural College, Central Farm, University College of Belize, and the Belize Center for Environmental Studies. Contact was also made with the Belize Audubon Society, Belize Zoo, Pan American Health Organization and USAID/Belize. Although it was not possible to study in depth the feasibility to conduct Phase III in Belize, it is believed that enough information was collected to allow NASA to decide whether such a study might be possible.

Malaria is a major public health problem in Belize. Three species of Plasmodium have been identified. Plasmodium vivax is the most common. P. falciparum is present and still relatively

unimportant but cases are increasing. These two species were also found in the Phase II study area of Mexico. A small number of P. Malariae cases have been diagnosed but it is believed the infections were acquired outside of Belize. Malaria is found throughout Belize mostly in rural areas but it does invade urban areas, especially on the urban-rural fringe. The malaria statistics are adequate and the National Malaria Service has operational and epidemiological records for almost 30 years. A number of consultant reports are available for background about the Service and its problems.

Little information is available on the vectors of malaria in Belize. Most of the information is old and may not be valid today. The major vectors apparently are An. albimanus and An. pseudopunctipennis, the same vectors as found in the Tapachula area. The habitat of these vectors seems to be similar as well. However, vectorial capacity, distribution, blood preference and other studies are lacking to confirm the importance of these and other species of Anopheles in the transmission of malaria in Belize. It appears that considerably more entomological studies will be required than were necessary in Tapachula.

A number of groups have published or are now studying the ecology and environment in Belize. The team was not able to locate all of these but NASA would be able to obtain fairly extensive information from documents cited in this report and by contacting the Belize Center for Environmental Studies and the Belize Audubon Society. The ecology of the two possible study sites are different. Cayo is low mountains with valleys and is heavily populated with extensive agriculture. Toledo also has low mountains but most of the malaria occurs in the coastal lowlands. Rainfall is very heavy in Toledo and the number of rainy days might limit remote sensing.

Professional expertise is lacking in Belize as the University College of Belize has only recently been established. The National Malaria Service has a staff of approximately 100 but all are required for routine malaria activities. There may, however, be several sources for field workers as both the Belize Agriculture College and the University College have biologists on their staff and some graduates might be recruited to work either full- or part-time. The USUHS has a laboratory in Belize and might be able to provide additional information on human resources.

The necessary vehicles, field equipment and supplies for Phase III would have to be furnished by NASA. There is an extreme shortage of vehicles as well as other equipment in the National Malaria Service. If Belize is selected NASA staff should visit the country to determine commodities and human resources needed.

A major problem in malaria control in Belize is the large number of migrants entering the country either as temporary farm labor or as refugees. In addition, there are many undocumented aliens throughout the country, especially along the Guatemalan

border. Refugee settlements such as Las Flores and Valley of Peace in Cayo are important malaria areas.

The following factors favor Belize as a potential site for Phase III of the NASA DI-MOD Project:

1. Vectors are similar to those in Phase II.

2. Topography is also similar.

3. Malaria is an important public health problem.

4. The Permanent Secretary of the Ministry of Health has expressed interest in the project.

5. The USUHS has a laboratory in Belize and a Letter of Agreement with the Government.

6. There is a database on malaria, some ecological and environmental information, and climatological records.

However, there are several other factors that might hinder progress on the project should Belize be selected. These include:

1. The condition of roads between Belize City and the study area.

2. The amount of rain and the number of rainy days (amount of cloud cover).

3. Lack of information on vectors, their distribution and habitats.

4. Lack of professional expertise available in the country.

5. The time required to collect basic information before could actual work on the project can begin.

4. Future Work

Over the next reporting period, U.T. El Paso plans to extend its previous investigations in Belize primarily through literature research. In addition, the U.T. El Paso interdisciplinary research team will await directions from NASA Ames Research Center concerning future trips to other countries of Central America which might serve as possible Phase III test sites. Investigations on sensor fusion will proceed through the summer months. It is anticipated that prototype computer algorithms for multi-spectral sensor fusion will be developed and implemented using the computer facilities located at U.T. El Paso. In addition, plans have been made for U.T. El Paso's participation in the July Investigators' Working Group Meeting to be held in Bethesda, Maryland.

Appendix I

Report

Evaluation of Phase III Resources in Belize, Central America for NASA DI-MOD Project

Prepared in Support of
Research Grant NAG 2-670

for the

NASA Ames Research Center
Ecosystems Science and Technology Branch
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The writers wish to acknowledge the help the Belize Ministry of Health gave the team. In particular, we would like to thank Mr. Fred Smith, Permanent Secretary of Ministry of Health, Dr. Jorge Palanco, Director of the National Malaria Service, Mr. Ed Boles of the Belize Center for Environmental Studies, Mr. Justin Holze, Sub-Director of the National Meteorological Service, Mr. Silvan Roberts, Chief Statistician of the Central Statistics Office and Mr. Eduardo Espat, Laiason Officer of the Refugee Service. Special thanks go to the malaria staff of Cayo and Toledo Districts, staff of the Central Farms, University College of Belize, USAID/Belize, Pan American Health Organization, Belize Zoo, and the Belize Audubon Society for their assistance.

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I. EXECUTIVE SUMMARY

A team from the University of Texas at El Paso (U.T. El Paso) visited Belize from 3 to 12 January 1991 to study the potential of that country as a site to conduct phase III of the NASA DI-MOD project. The first phase of the project was done in the central valley of California and demonstrated that it was possible to predict changes in mosquito populations using remote sensing and radar. Furthermore it showed that certain rice fields in the area produced more mosquitos than other fields. A combination of pinpointing areas of greater mosquito production and monitoring changes in mosquito larval densities in areas could increase the effectiveness of malaria control and reduce cost considerably. Because of the success in California, phase II was begun along the southern Pacific coast of Mexico near Tapachula. The major vectors of this area are Anopheles albimanus and An. pseudopunctipennis. Field studies have shown certain habitats produce most of the mosquitos and the dominant vegetation associated with each has been identified.

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The team consisted of an electrical engineer (team leader), a sociologist/demographer, a parasitologist, and an entomologist. The team visited two possible districts of Belize in which the National Malaria Service encounters the greatest problem with malaria. These were along the Western Highway in Cayo district between Belmopan and the Guatemalan border and near Punta Gorda in the southern district of Toledo. The team met with staff from the Ministry of Health concerning malaria, the National Meteorological Service for rainfall and temperature data, the Rufugee Service for information on refugee settlements and immigration, and the Central Statistics Office for general information about the country. To determine potential human resources, the team met with staff from the Belize Agricultural College, Central Farm, University College of Belize, and the Belize Center for Environmental Studies. Contact was also made with the Belize Audubon Society, Belize Zoo, Pan American Health Organization and USAID/Belize. Although it was not possible to study in depth the feasibility to conduct phase III in Belize, it is believed that enough information was collected to allow NASA to decide whether such a study might be possible.

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throughout Belize mostly in rural areas but it does invade urban areas, especially on the urban-rural fringe. The malaria statistics are adequate and the National Malaria Service has operational and epidemiological records for almost 30 years. A number of consultant reports are available for background about the Service and its problems.

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A major problem in malaria control in Belize is the large number of migrants entering the country either as temporary farm labor or as rufugees. In addition, there are many undocumented aliens throughout the country, especially along the Guatemalan border. Refugee settlements such as Las Flores and Valley of Peace in Cayo are important malaria areas.

The following factors favor Belize as a potential site for phase III of the NASA DI Mod Project:

1. Vectors are similar to those in phase II.

2. Topography is also similar.

3. Malaria is an important public health problem.

4. The Permanent Secretary of the Ministry of Health has expressed interest in the project.

5. The USUHS has a laboratory in Belize and a Letter of Agreement with the Government.

6. There is a database on malaria, some ecological and environmental information, and climatological records.

However, there are several other factors that might hinder progress on the project should Belize be selected. These include:

1. The condition of roads between Belize City and the study area.

2. The amount of rain and the number of raindays (amount of cloud cover).

3. Lack of information on vectors, their distribution and habitats.

4. Lack of professional expertise available in the country.

5. The time required to collect basic information before could actual work on the project can begin.

II. INTRODUCTION

The NASA DI-MOD project was designed to be completed in three phases. The first was accomplished in California where mosquito populations were studied in rice fields. The study demonstrated that it was possible to predict increases in mosquito populations by the use of remote sensing and radar. The second phase is being conducted near Tapachula in the Pacific region of southern Mexico. This phase is beginning to produce results and it was considered feasible to begin the process of selecting an area for phase three. In July 1989 a team from U.T. El Paso) visited Costa Rica. The team considered that the Pacific coast of Costa Rica in Guanacaste had many conditions favorable for the NASA study. However, it was concluded that other potential sites should be visited before the final selection. From January 3 to 12, 1991, the U.T. El Paso team visited Belize and this report covers their findings.

Phase III will consist of field verifications of the predictive model developed at Tapachula, Mexico. Anopheles albimanus and An. pseudopunctipennis are found in Mexico and Belize and it should be possible to conduct a similar systematic search for a relationship between remote-sensed signals and the occurrence of Anopheles albimanus and pseudopunctipennis larvae.

The following were considered as the primary criteria for site selection: (1) the importance of malaria as a public health problem, (2) the interest of the host government and its ability to participate in the project, (3) the availability of technically qualified personnel, (4) the quality and quantity of data bases, (5) the accessibility of the study area, and (6) the intergovernmental relations. The team utilized these criteria as the basis of this report.

III. BACKGROUND

1. General

Belize formerly was known as British Honduras. It was renamed in 1973 and became independent in 1981. Belize City was originally the capital but the capital was moved inland to Belmopan to avoid hurricanes. The country is 451 km north to south and 109 km east to west. The Caribbean coast line is 280 km. It is a land of mountains, swamps and tropical jungle. The northern part of the country is low, mostly less than 60 M above sea level, and swampy, There are many lagoons near the coast. Besides the swamps and lagoons, there is an extensive low lying open savanna that was once hardwood forest. Now the trees are mostly oak, pine and palm with mangrove trees near the coast. The south is rugged and mountainous except along the coast.

Belize borders the southeast shoulder of the Yucatan Peninsula. Mexico lies to the northwest, Guatemala lies west and south, and the Caribbean sea is to the east. Belize is 22,965 sq. km (8,827 sq. miles). Over 50 species of trees occur in the country. The north has deciduous, sapota, mahogany and ironwood while the south has oak, pine and cedar. Since 1978 there has been a reforestation program and gmelina, eucalptus and pine are being planted. It is estimated that there are about 3,240 species of plants of which 27 are rare or threatened species.

There is considerable annual variation in rainfall because of hurricane activity. The northern plateau averages from 1000 to 1500 mm (40-60 inches) per year and the southern mountainous areas average 2500 to over 4000 mm (100-160 inches) per year. The dry season is from February to May and the wet season from June to November with a shorter dry period in August and September. Rains slack off in December and January. The average mean temperature is 26 C and average humidity is 83%. The average temperature in December in Belize City is 23 C and in July 29 C.

The national language is English but Spanish is widely spoken, especially in recent years because of the influx of immigrants from El Salvador and Guatemala. Belize had a population of 144,857 in 1980. The population was estimated to be 165,000 in 1985, 176,000 in 1987 and 190,000 in 1990. It is predicted that the population will reach 249,000 in the year 2000 with a doubling time of 20 years. Over 52% of the population is urban. The population density is about 7.3 per sq. km. Belize City had about 47,000 inhabitants in 1987 and about 65,000 in 1990. The population is approximately 40% Creole with centers of Garifuna people (African-Caribe Indians) in the southern coastal villages. In the highlands there are Kekchi Maya villages and scattered throughout the country are Mennonite communities.

The economy is based on agriculture, fishing and light industry. Sugar cane is one of the major crops in the north and

oranges, grapefruit, bananas, rice, maize, beans and vegetables are grown near the coast. In 1980, the GNP was $1080 per capita. The external debt in 1986 was $119,000,000 and this rose to $139,000,000 in 1987.

Education is compulsory between ages 6 to 14 and about 90% of the population is literate. Schools are mostly run by churches. Most university students have to leave the country for their education but Belize City has the Belize College of Arts, Science and Technology, a branch of the University of the West Indies, and Wesley College. Recently, the University College of Belize was established and offers a Bachelor of Education with specialties in Chemistry, Biology and English. The Teachers College of Belize continues to offer a two year program for primary school teachers. The Central Farms in Cayo District is the site of the Belize Agricultural College, another two year school. Fletcher College is located in Corozal.

Going from coastal Belize southward are the districts of Corozal, Belize, Stann Creek and Toledo. The districts of Orange Walk and Cayo are located inland (see Map 1). Tables 1 and 2 give information concerning the districts and major cities of Belize.

Table 1. Information on the districts of Belize (1990)

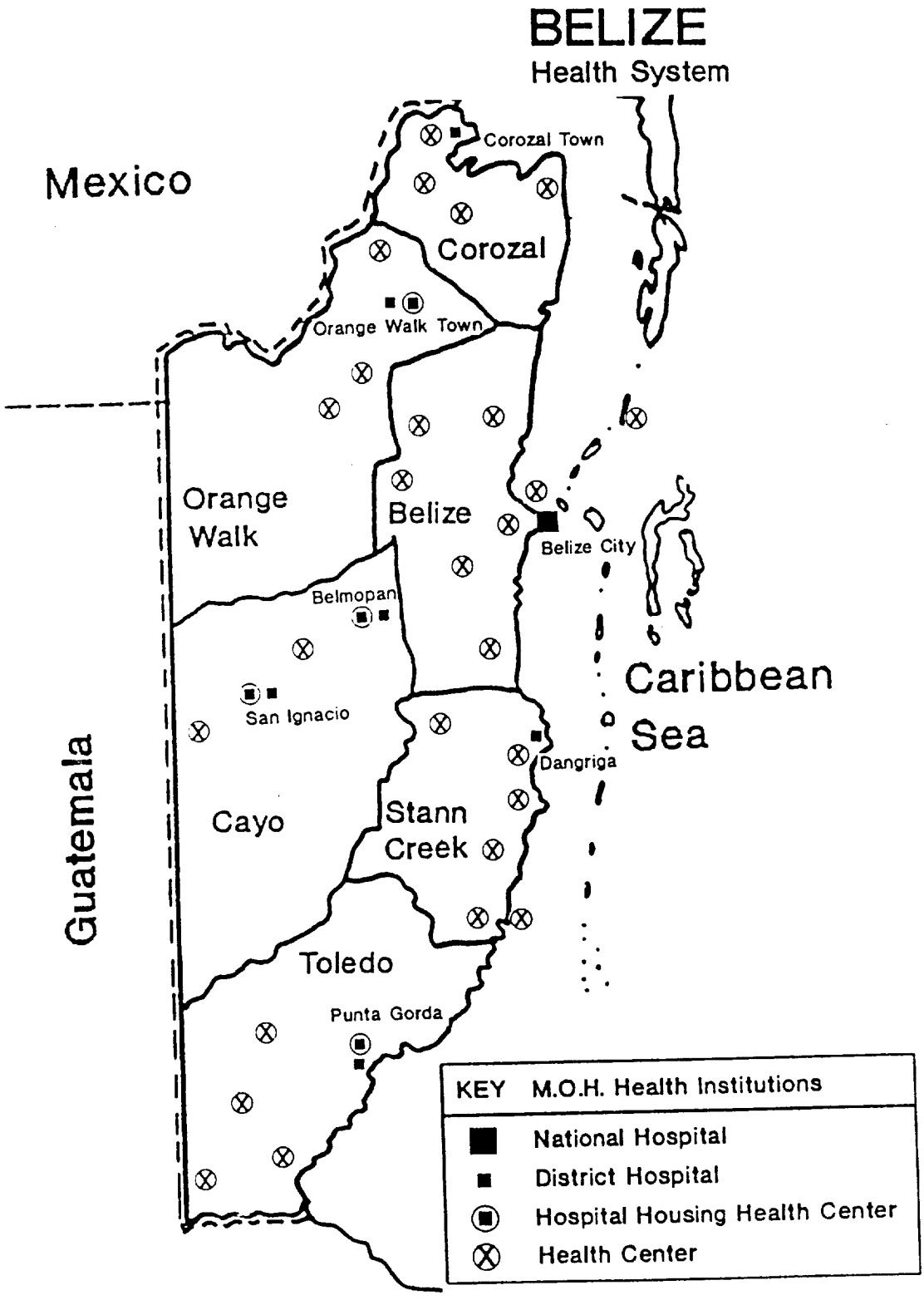
DISTRICT	CAPITAL	SQ. KM.	POPULATION
Belize	Belize City	4200	65,604
Cayo	San Ignacio	5335	29,881
Corozal	Corozal	1860	29,242
Orange Walk	Orange Walk	4737	29,936
Stann Creek	Dangriga	2176	28,330
Toledo	Punta Gorda	4649	15,073

Table 2. Population of Major Cities (1985)

Belize City	47,000
Corozal	10,000
Orange Walk	9,600
Dangriga	7,700
Belmopan	4,506

2. National Statistics for Belize (1990)

During their visit to Belize, the U.T. El Paso team collected basic statistics relating to the population and the population dynamics of the country. Table 3 gives an indication of the



Map 1. Belize Health System

distribution of the population with respect to age.

Table 3. Population distribution by age.

Age	Percent in Group
under 15	44.9
15 to 29	28.0
30 to 44	12.0
45 to 59	7.8
60 to 74	5.0
75+	2.3

In their research, the team was able to assemble a number of facts which seem important in assessing the population dynamics of Belize. They include:

Crude birth rate is 37.2 per 1000 live births.
Crude death rate is 4.0 per 1000.
The natural increase rate is 36.1.
The average number of births per childbearing female is 4.9.
The life expectancy is 69.8 years for males and 71.8 for females.
The rate of natural population increase is 2.8%.
Population growth rate is 2.4%.

Analysis indicates a likelihood that the population of Belize will continue to grow rapidly over the next several decades. Table 4 gives a projection of population through the year 2020.

Table 4. Population growth estimates

Population in 1000s	1960	1965	1970	1975	1980	1985	1990	1995	2020
	92	106	120	140	162	184	205	223	234

The most recent information places 133 persons per Sq. Km of arable land giving Belize one of the worlds lowest population densities. In terms of the availability of medical care, Belize had 525 hospital beds and 91 physicians (5 physicians per 10,000 population) in 1989. Table 5 gives statistics concerning births and death in Belize.

Table 5. Births and deaths (1989)

Number of live births	6581
Crude Birth Rate	37.2
General fertility rate/woman	5.2
Total deaths	762
Mortality Rate	4.2
Infant Deaths	132
Infant Mortality Rate	19.4

Sixty-four percent of the total population has access to safe drinking water (100% of urban and 26% of rural population) and 45% of the population has access to indoor sanitation services.

3. Statistics on Malaria

Belize has one of the highest levels of annual parasite incidence (API) in the Americas (29.52 cases per 1000 population in 1989). The API in 1985 was 17.50%, in 1986 it was 16.64%, in 1987 it was 25.02% and in 1988 it was 21.16%. Table 6 gives a breakdown of the malariometric rate including the API for selected years. Much of the problem has been the seasonal migration of workers for the banana and citrus harvest from Guatemala, Honduras and El Salvador as well as refugees due to the political unrest in the area.

Table 6. Malariometric rates.

YEAR	API	Annual Vivax Incidence	Annual Falciparum Incidence
1960	2.12	1.52	0.60
1965	1.93	1.76	0.17
1970	0.26	0.24	0.04
1975	0.64	0.64	0.00
1980	10.54	10.31	0.23
1985	17.18	16.58	0.60
1989	18.46	14.70	0.53

In 1989 the estimated total population for Belize was 178,000 with 166,000 of the population living in the original malarious area. In 1989, 94,000 people were living in the area under attack (56%) and 72,000 were living in the area under consolidation (43%). The incidence rate for malaria is not uniform throughout the districts of Belize. It was found that 40% of all malaria cases

occur in the Cayo district while 21% are from the Toledo district.

The National Malaria Service has a program for taking blood samples from individuals suspected of being infected. Table 7 presents information from 1989 pertaining to this program.

Table 7. Number of blood slides examined.

	Total	Maintenance	Consolodation	Attack
Examined	19,806	432	6,220	13.154
Positive	3,285	95	943	2,247
Per cent	16.59 of which 97.7 were vivax			

The number of malaria cases registered from 1986 to 1989 were as follows:

1986	2,779
1987	3,258
1988	2,725
1989	3,285

Table 8 gives a breakdown of malaria cases by type, while Table 9 gives an indication of the amount of DDT administered in the country in 1989.

Table 8. Epidemiological situation for 1989.

P. falciparum	70 cases
P. vivax	3,208 cases
P. malariae	7 cases

Table 9. Insecticide used (1989).

DDT (kg)	100%	8,500
DDT (kg)	75%	17,000

IV. FINDINGS

1. Meteorological

The National Meteorological Service is located at the Philip S. W. Goldson International Airport. The office is well equipped and staffed. There are three computers using WMO standard climatological software programs and a fax which connects the Service with the Hurricane Center in Miami. The Service has records going back before independance, so the data base is extensive and easy to retrieve. It has weather information from over 30 stations covering the country.

Selected climatological information is given in tables in Annex 3. Cayo and Toledo Districts are of special interest because of the number of malaria cases present. Table 10 presents some information on rainfall and raindays.

Table 10. Annual rainfall for Cayo and Toledo districts.

	Annual Rainfall (mm)		Annual Raindays	
Year	Cayo	Toledo	Cayo	Toledo
1983	1866.20	*	134	*
1984	1273.40	4529.40	117	183
1985	1410.60	3922.01	128	188
1986	1748.10	*	138	*
1987	1385.60	*	113	*

* Note: These data are available through the National Meterological Service, yet are not reported here. The team did not collect data for all years for both districts.

Since cloud cover is likely to occur even on days without rain, there may be limited opportunities to make optimum use of remote sensing in either area. The Land Resources Development Centre of England has done land resource assessment studies in Toledo and staff at the Belize Agricultural College at Central Farm mentioned that problems had occurred with aerial photography during the study. The amount of rainfall and subsequent flooding will also hinder some ground activities.

Rainfall and temperature may be factors in the distribution of the major malaria vectors in Belize. There are fluctuations in daily minimum and maximum temperatures but the average daily temperatures by month vary little, as is indicated in Table 11.

Table 11. Average temperature by season.

	Summer Avg. High (F)	Winter Avg. Low (F)
Punta Gorda	79	72
Belmopan	83	68
Central Farm	83	70

2. Ecology

According to Hartshorn, Belize has five ecological zones. They are as follows: 1) subtropical moist, 2) subtropical low mountain moist, 3) subtropical low mountain wet, 4) subtropical wet, and 5) tropical wet in transition to subtropical. Cayo District is mostly subtropical moist and Toledo varies from being subtropical wet along the coast (Punta Gorda) to subtropical low mountain wet away from the coast. There are 18 major drainage patterns in Belize. The malaria area of Cayo falls mostly along the Macal/Belize River but several rivers are found in the Toledo District. Although the Cayo district is more agricultural with beans, corn and citrus among the main crops, the Toledo district also has corn, beans, and citrus along with mangos, bananas, and rice.

Traveling from Belize City on the Western Highway, there is a belt of mangrove swamp. During the rainy season it is mostly flooded even though drainage ditches are common. There is a gradual transition to low-lying palms which are replaced by scattered pine trees at about Km 25. The major endemic area begins at Belmopan and lies along the Western Highway to the Guatemalan border. This is an agricultural area with many small villages and scattered housing along the road.

The endemic area is different in the Toledo district. The low mountains are fairly close to the Caribbean coast. Since rainfall is higher, the area has thick green scrubs and trees. Outside of the villages, houses are more dispersed. There is usually a small clearing around the house but the farm land may be some distance from the house as it is a cut and burn type of temporary farming. This situation seems to allow for a greater dispersion of malaria cases than found in the Cayo District.

The Smithsonian Institute has conducted ecological studies in the southern part of Belize. Recently, the Missouri Botanical Gardens did a plant survey in Belize. It is published by J. Dwyer and J. Sparman in Rhodora and copies are available at the Belize Audubon Society (49 Southern Foreshore, Telephone 77369: Contact Mrs. Dolores Godfree or Mrs Lydia Weight). There is a Belize Ethnobotanical Institute which may sponsored in part by the Brooklyn Botanical Gardens working in the Cayo district which might

have information on plants of the area. USAID/Belize has corresponded with staff of the IX Chel Farm (General Delivery, San Ignacio, Cayo) about environmental studies. USAID/Belize is involved with a National Resource Protection Project which might be of help.

The Overseas Development Natural Resources Institute and the Land Resources Development Centre of England have done land resource assessments in a number of areas (along the Belize river water shed, Stann Creek district and Toledo district). Aerial photography was used in some of the work. If Belize is selected, Dr. Bruce King, Natural Resource Institute, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK or the Land Resource Development Centre, Telworth Towers, Surbuton, Surrey, KT6 7DY, UK should be contacted. The Belize Center for Environmental Studies in cooperation with the Department of Geography of the University of Edinburgh has done a study on mangrove swamps (see Gray, Zisman and Corves 1990, Mapping the Mangroves of Belize). Also, the Center has conducted a Critical Habitat Study (in preparation) for the World Wildlife Fund and has begun a nation-wide environmental impact assessment.

3. Malaria

Malaria is an important public health problem in rural Belize. It was the leading reportable disease in 1988 (2,725 cases) and in 1989 (3,285 cases). Three species of Plasmodium are involved: P. vivax, P. falciparum and P. malariae. The majority of the cases are produced by P. vivax but there has been a slight increase in falciparum malaria over the years. The two most important malarious areas are found in Cayo and Toledo districts. Of the two areas, Cayo appears to be the best area for Phase III. Logistically it is easier to reach from Belize City as the road is good and all endemic villages can be usually reached in about one to two hours. The majority of the villages border the Western Highway and the National Malaria Service office in San Ignacio for the Cayo district is one of the best staffed and equipped in the country. The Central Farm and Belize Agricultural College are on the highway near San Ignacio would be potential sources of human resources. Furthermore, since Cayo district has less rainfall and raindays, it might be easier to perform the remote sensing than in the Toledo District.

Villages with the largest number of malaria cases for Cayo and Toledo districts are given in Table 12.

Table 12. Most positive localities for Toledo and Cayo districts.

TOLEDO	CAYO	
village	village	cases
1. Bigfalls	1. Las Flores	166
2. Punta Gorda	2. Belmopan	108
3. Crique Sarco	3. Over the Top	87
4. Silver Creek	4. Roaring River	66
5. Rancho	5. Benque Viejo	65
6. Golden Stream	6. Valley of Peace	61
7. Greens Creek	7. San Ignacio	49
	8. Belmopan Cooper.	46
	9. Camalote	43
	10. Teakettle	42

* Note: The number of cases are available only for villages in the Cayo district.

Not all of the data are available for 1990 as some December cases are still not reported. To date there has been 2929 cases of malaria of which 793 cases come from Toledo district and 1197 cases from Cayo district. See annex 4 for the 1990 malaria data as supplied by the National Malaria Service.

No recent mosquito surveys have been done in Belize. The USUHS has conducted some entomological studies in Belize, but this information is not yet available. Austin (1981) collected An. albimanus, An. apicimacula and An. vestitipennis and reported more An. vestitipennis than An. albimanus in Punta Gorda. In 1979, Bown reported making collections at Sand Hill Village. Three species were collected both inside and outside of houses: An. vestitipennis (more outside), An. albimanus (fewer collected but more outside) and An. punctipennis (very few collected but more inside of houses). Bown and Rios (1984) in Corozol and Orange Walk collected from animal corals and from human bait An. vestitipennis (7%) and An. albimanus (92+%). Two specimens of An. punctimacula were collected. In Cayo they collected only 3 An. albimanus and in Punta Gorda only 78 An. albimanus. Bown (1989) working with an anopheline ecology team in Cayo district used human bait and light traps, only An. albimanus and An. vestitipennis were collected. The British military has done some mosquito surveys (see annex 4). Cruz (1988) outlined a strategy for stratification of malaria in Belize and listed anopheline species found by Belkin and others doing surveys in British Honduras. The list includes the following: An. albimanus, An. apicimacula, An. argyritarsis, An. crucians, An. darlingi, An. eiseni, An. intermedius, An. neomaculipalpus, An. pseudopunctipennis, An. punctimacula and An. vestipennis. The literature provides only scanty information on

the mosquito species found in Belize and their distribution. In general the following species were the most frequently collected:

Cayo district: An. albimanus, An. vestitipennis, and An. apicimalula

Toledo district: An. albimanus and An. vestitipennis

Belize district: An. albimanus, An. vestitipennis and An. punctipennis

Corozol district: An. albimanus and An. vestitipennis.

A few biological or ecological studies have been done but are out of date. As a result, considerable entomolgical information would have to be collected before Phase III ground truthing could begin. In some cases, even the vectors are unknown or their role questionable.

The situation of insecticide resistance is equally confusing. It is the only country in Mesoamerica still using DDT exclusively and the DDT that they are using is fifteen years old. Staff of the Ministry of Health reported an increase in refusals to spray houses and that DDT does not work as well as in the past. Since 1978, consultants have mentioned the possibility of DDT resistance, but tests have shown little evidence for this. In some districts, mosquito mortality has been repeatedly less than 100% and as low as 80% has been reported. Most consultants recommend additional tests because of the number of specimens used in the past or the conditions under which the tests were conducted. If Belize is selected, the status of DDT resistance will need to be confirmed.

Chen (1979) noted that malaria transmission in Cayo and Stann Creek begins in early May while in Corozol, Orange Walk and Toledo it begins in late June. This still appears to be the case (see annex 4). In 1990, the peak incidence was in August and the low apparently will occur in December. In 1989, the peak occurred in June and was not as high as in 1990. The low for 1989 was in January and February. There is considerable variation as demonstrated in data from Toledo given in Table 8.

The above data were obtained from field records and are subject to error. However, it shows the variation from year to year of recorded cases and the number of villages having malaria cases. There are 55 localities checked in Toledo and malaria is widespread among them. The records indicate that, frequently, a number of cases were reported in the same family or in the same cluster of houses.

4. Human Resources

Until recently, Belize lacked true centers of higher education. As a result, it does not have the trained personnel required for Phase III of the DI-MOD study. However, the potential is present and field staff could be recruited, hired, and trained.

Because of the current problem in controlling malaria, the National Malaria Service does not have staff to spare for routine mosquito larvae collections such as were done in California and are now being carried out in Mexico. There are two entomological assistants that have been trained in Tapachula, Mexico. One is assigned to the Cayo district (Mr. Escalante) and the other is in Corozal, however, both now work as malaria evaluators.

Recently the Government of Cuba sent a number of physicians and paramedical staff to Belize to strengthen the general health services. An entomologist, Omar Fuentes Gonzales, has been assigned to the National Malaria Service, however, he has been unable to work effectively in his area of specialty because of transportation and staff problems. It is hoped that he will be able to accomplish the goals set for the consultantship, but he most likely will not be there long enough to be of help the NASA project.

The USUHS has established a laboratory on Princess Margaret Road in Belize City and permanent staff will be on duty soon. Entomologists from USUHS have worked in Belize and know the malarious areas. These scientists might be the best source of expertise.

There are three other groups which might be of assistance should Belize be selected. One is the new University College of Belize which at present offers a Bachelor of Education degree with minors in English, Chemistry or Biology. Ms Robin McCutchen is professor of biology. There are about 20 students minoring in biology and some could probably be recruited during school vacations to supervise field work. Ms Inga Kellogg is the instructor of field botany and most students have taken or will take her course. Consequently, there is some expertise for ground truthing. Another source for temporary supervisory staff might be the Belize College of Agriculture at Central Farm. The College is located in the Cayo district which is the major malarious area. Although the courses are agriculturally oriented, most students have a good foundation in biology, agronomy, and hydrology. Newly graduated students might be recruited for one or more years to work in the field. Staff from both the Farm and College showed interest in cooperating with the project. Ms. Carol August would be a key contact.

Another source of expertise is the Belize Center for Environmental Studies in Belize City. National and international scientists come there to research various aspect of ecology. At present a publication on a critical habitat study sponsored by the World Wildlife Fund is in preparation. Mr. Ed Boles would be a

contact for the center.

Although PAHO does not have human resources to assist in the study, it does have a computer center and library that would be of value. The Office has offered full support of the project should Belize be selected.

5. Logistics

The Philip Goldson International Airport has daily flights from Houston, New Orleans and Miami. It can be reached from the USA by flights from nearby Mexican airports, as well. There is a small municipal airstrip in Belize City that has scheduled daily flights to the major population centers and the cayes in the country.

The Northern Highway to the Mexican border is flat and fairly good. However, it does not pass through the major malarious areas. Cayo and Toledo districts can be reached by the Western Highway which runs from Belize City to the Guatemalan border. It is excellent until Belmopan but is narrow and rough from there to the border. The Hummingbird Highway runs from Balmopan south to Punta Gorda. Four wheel drive vehicles are recommended for this highway, especially during the rainy season. A new coastal highway is under construction but until it is completed, air travel to Punta Gorda is recommended.

Because of the roads in the Toledo district, this malarious area would be difficult to study for an extended period of time. A second drawback is that Punta Gorda records the most rainfall in Belize.

6. Demography and Sociology

The Government publishes as ABSTRACT OF STATISTICS annually. In April 1991, a nation-wide census will begin. The Central Statistical Office in Belmopan has a well trained staff and Mr. Silvan Robert, Chief Statistician, should be contacted for background information. The National Malaria Service maintains records of malaria cases by village, district, age, sex and parasite species. Recently, the Ministry of Health and the Pan American Health Organization published the "National Health Planning System: 1990-1994 Basic information for National and Local Health Planning". There is also a MOH-PAHO Newsletter on health activities in Belize that might provide demographic information. In addition, the Society for the Promotion of Education and Research (SPEAR) has published a Profile on Belize 1989 which has usefull information about the socio-economic, socio-cultural and political forces in the country.

The United Nations High Commissioner for Refugees (UNHCR) has an office in Belmopan at 20/24 Cardinal Avenue which works closely with the Refugee Section of the Ministry of Foreign Affairs (19/21 Halfmoon Avenue, Belmopan). Most of the refugees are from Guatamala and El Salvador. The two agencies promote a program for refugees and a rural settlement project has been established at Valley of Peace. Another major settlement is in Las Flores immediately ouside of Belmopan. These are both malarious areas.

In 1989 an International Conference on Central American Refugees (CIREFCA) was held in Guatamala City. As a result of CIREFCA, Belize formed a National Committee on Refugees. A contact person for the Committee is the Honorable Ismael Garcia.

Although it is recognized that refugees are part of the malaria problem, the exact role they play is uncertain. People crossing back and forth between malarious area in Belize and their native country carry the parasite. This is a source of malaria as the vectors are present in the rural villages of Belize. Those individuals with refugee status are served by health promotors and malaria voluntary collaborators but those that are undocumented or considered aliens might not be reached by the Ministry of Health staff. The number of aliens in Belize is unknown but may be as high as 40,000 individuals. Temporary workers come into Belize from Honduras, Mexico, and Guatamala during harvest, but they are usually documented and served by the MOH.

Another problem with migrants is that they often are less educated than the people of Belize and do not recognize the importance of treatment for malaria or prefer to use traditional medicine which might not be as effective.

The role of humans in a malaria model is important, yet poorly understood. It, along with the parasite and the vector, form the basis for the model, but historically it has been the human aspect that has been ignored. Of special interest is the role the human factor should play in the DI MOD project. The ultimate test of the model will not be the finding of a relationship between mosquitos and vegetation, but if targeted control within the areas shown to have the highest mosquito densities actually reduces malaria in the human population to be monitored.

Table 12. Monthly distribution of malaria.

	1986		1987		1988	
	cases	villages	cases	villages	cases	villages
Jan.	10	9	9	5	12	6
Feb.	7	7	10	7	8	6
Mar.	15	7	18	10	11	8
Apr.	17	8	6	6	12	8
May	7	5	18	7	24	13
June	19	9	5	4	27	13
July	21	11	11	5	45	18
Aug.	19	11	38	15	66	16
Sept.	3	2	33	13	47	13
Oct.	11	5	38	14	32	18
Nov.	6	4	18	7	31	15
Dec.	3	3	9	7	31	15

V. DISCUSSION

Conditions in Belize may be sufficiently similar to the area near Tapachula, Mexico to allow for Phase III of the Project. The major concerns of the team centered on climatology, i.e. the amount of rainfall, number of raindays and the amount of cloud cover. The National Meteorological Service does not record cloud cover. However, the number of days of rain and information collected from the Central Farm indicated that planning for remote sensing might be difficult.

Another concern was the condition of the roads during the rainy season. This seemed to us to rule out using Toledo district as a study site. Even in Cayo when the rains are heavy, flooding occurs and it might be difficult to reach the study sites or to study them.

Malaria occurs throughout the year but does exhibit peaks and valleys. It varies somewhat from year to year and climatological records should be compared with cases over time.

Little is known about the vectors in Belize. Consultant reports indicate that as a rule few vectors have been caught for study. It is difficult to identify all of the reasons for this, but it appears that at certain times, the adult mosquito population is low. Even less seems to be known about the habitats of the immature stages. Care must be given to the time and financial support needed to undertake base line studies to bring conditions comparable to the beginning of phase II in Mexico.

Nothing was found that would completely eliminate Belize as a possible site for the project. Many groups and agencies expressed great interest in the project, and it would appear that a high level of cooperation could be achieved. Technically it would benefit the country as the scientific information generated by the project would help the MOH and others.

How the model would be utilized in Belize is of concern. An objective would be to provide an early warning system which would allow the MOH to target control activities in a way that would be effective and reduce the cost of the operation. The objective coincides with the concept of malaria stratification promoted by WHO: stratification should assign priorities to areas placed under malaria control. There are various criteria for assigning priority and a number of these center on the vector and the environment. Thus, any spin-off from a NASA study at the ground level would benefit those assigned the duty of stratification. The actual control activity seems to be the weak point. To date, the NASA project has not really planned a control component. Yet, to demonstrate that remote sensing and radar are effective tools, some type of control, such as use of a biological agent, should be applied to the identified breeding sites and the effect of the agent on not only the vector, but on malaria transmission to man studied.

VI. CONCLUSIONS

1. Belize meets most of the criteria for selection, but outside of the public health importance of malaria, Guanacaste in Costa Rica might be the better study site. In any event Costa Rica should be subjected to an in-depth evaluation.

2. Belize should be visited by NASA staff or consultants as well as USUHS staff before the final selection is made.

3. Belize has the potential for the sociological aspects outlined in the U.T. El Paso grant.

VII. LITERATURE

General Documents and Pamphlets

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CIREFCA International Conference of Central American Refugees. Follow-up in Belize.

SPEAReports 2. Socioeconomic Integration of Central American Immigrants in Belize. April 1990.

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Belize Facilities map, a handy quide of visitors

Atlas of Belize; 12 detailed maps and facts about Belize

Paul Glassman, 1989. Belize Guide. Passport Press Champlain, New York.

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Overseas Development Natural Resources Bulletin Land Resource Assessment of Stann Creek District, Belize

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Gray, Zisman and Corves, 1990. Mapping The Mangroves of Belize. Department of Geography. University of Edinbough.

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VIII. Annexes

Annex 1. People Contacted

Annex 2. Itenerary

Annex 3. Climatology

Annex 4. 1990 Malaria Information from the National Malaria Service

Annex 1. People Contacted

Ministry of Health

Mr. Fred Smith, Permanent Secretary

National Malaria Service

Dr. Jorge Polanco, Director
Mr. C. Silva, Chief Malaria Laboratory
Sr. Omar Fuente Gonzalas, Entomologist (Cuba)
Mr. O. Rivera, Evaluator, Cayo district
Mr. Escalante, Evaluator, Cayo district
Mr. Orlando Chan, Evaluator, Toledo district
Mr. Gadnin Humes, Evaluator, Toledo district
Mr. Harry Johnston,, Aedes Inspector, Toledo district
Mr. Javier Chan, ULV Operator, Toledo district

National Meteorological Service

Mr. Justin Holze, Sub-director

Belize Center for Environmental Studies

Mr. Ed Boles, Consultant
Mr. Evan Cayetano, Marine Biologist

University College of Belize

Ms. Robin McCutcheon, Biologist

Belize Zoo

Ms Sharon Montola, Director

Central Medical Laboratories

Mr. Walwyn Tillett, Senior Medical Technologist

Central Statistics Office, Belmopan
Ministry of Economic Development

Mr. Silvan Roberts, Chief Statistican
Ms. Lynn MacDonald, Economic Satistican

People Contacted (cont.)

Refugee Service, Belmopan
Ministry of Foreign Affairs

Mr. Eduardo Espat, Laiason Officer
Ms. Nacia Carrillo, Administrator
Ms. Cynthia Pitts, Legal Officer
Ms. C. Cayamera, Social Worker

US Centers for Disease Control

Dr. Bill Brady, CDC/STD Consultant

Central Farm and Belize Agricultural College

Mr. C. Cal, Director
Ms. Carol August, Biologist
Mr. H. O'Brien, Agronomist
Mr. John Link, Plant Pathologist

USAID/BELIZE

Mr. Patrick McDuffy
Ms. BiBi Essama

Pan American Health Organization

Dr. Cesar Hermida, Program Coordinator

Annex 2. Itenerary

3 January 1991

Trip: El Paso to Belize City

4 January 1991

Meetings: National Malaria Service

National Meteorological Service

Belize Center for Environmental Studies

University College of Belize

5 January 1991

Field Observations Belize District

6 January 1991

Belize Zoo

7 January 1991

Meetings: Belize Center for Environmental Studies

Central Medical Laboratory/USUHS

National Malaria Service

8 January 1991

Meetings: Ministry of Foreign Affairs/Refugee Service

Ministry of Economic Development/Central Stat.

Central Farm and Agricultural College

Visits: Las Flores Refugee Settlement

9 January 1991

Meetings: National Malaria Service/ Cayo District

Visits: Endemic areas in Cayo District

Itenerary (cont.)

10 January 1991

Meetings: National Malaria Service/ Toledo District

Visits: Endemic areas near Punta Gorda

11 January 1991

Meetings: National Malaria Service

Pan American Health Organization

USAID/Belize

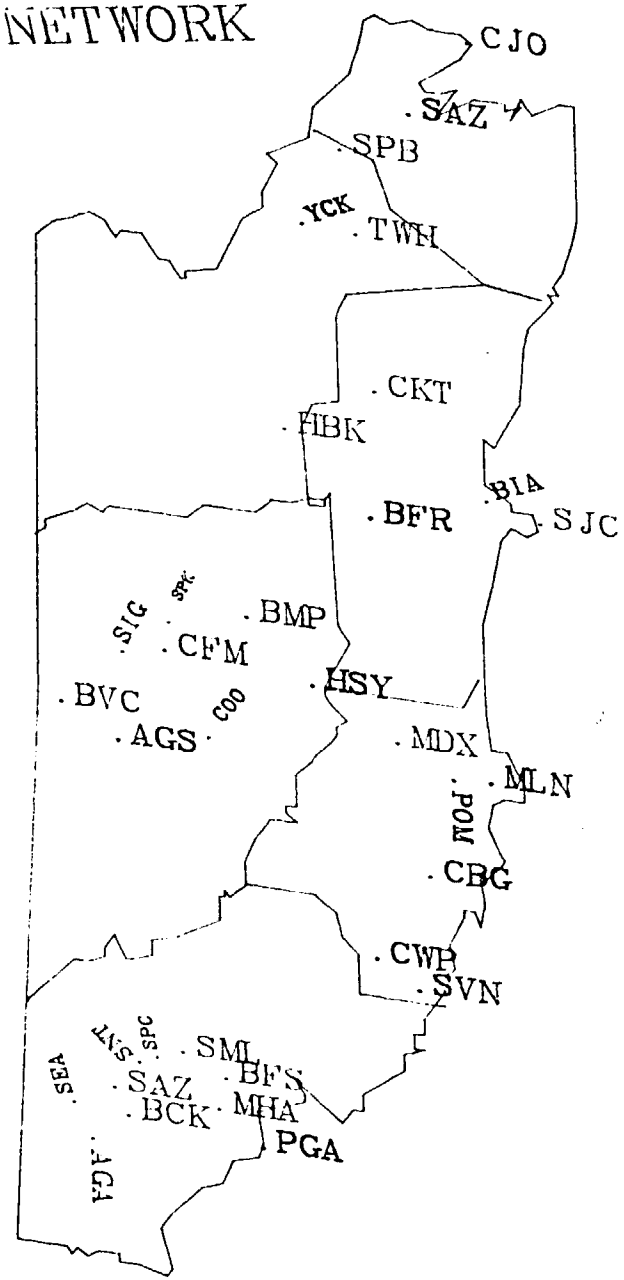
12 January 1991

Trip Belize City to El Paso

Annex 3. Climatology

1. Map of Belize weather station network
2. Daily Rainfall (millimeters) at Central Farm for 1983
3. Daily Rainfall (millimeters) at Central Farm for 1984
4. Daily Rainfall (millimeters) at Central Farm for 1985
5. Daily Rainfall (millimeters) at Central Farm for 1986
6. Daily Rainfall (millimeters) at Central Farm for 1987
7. Daily Rainfall (millimeters) at Belmopan for 1986
8 Daily Rainfall (millimeters) at Belmopan for 1987
9. Daily Rainfall (millimeters) at Toledo Agstat for 1984
10. Daily Rainfall (inches) at Punta Gorda for 1985
11. Average temperature for Central Farm (Cayo)
12. Average temperature for Belmopan
13. 10 year average: Climatic Data for Punta Gorda

DISTRICT STATION NETWORK



. AGROMET STATIONS

. RAINFALL STATIONS

. SYNOPTIC STATIONS

BELIZE WEATHER BUREAU

DAILY RAINFALL (MILLIMETERS") AT CENTRAL FARM FOR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2.00	0.00	0.00	0.00	0.00	18.00	0.00	4.60	8.40	0.00	10.70	3.00
2	4.60	0.00	0.00	50.80	0.00	38.00	3.00	2.50	3.30	13.20	0.00	3.80
3	24.90	0.00	0.00	0.00	0.00	6.30	0.00	17.80	0.00	8.10	0.00	0.00
4	3.80	1.50	0.00	0.00	0.00	0.00	23.60	0.00	0.00	13.90	0.00	0.00
5	0.00	4.10	0.00	0.00	0.00	0.00	8.40	0.00	0.00	0.00	2.50	0.00
6	4.80	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	15.70	11.40	0.00
7	1.30	0.00	0.00	0.00	0.00	0.00	44.90	5.10	0.00	0.00	20.80	0.00
8	0.00	12.70	0.00	0.00	0.00	0.00	22.30	7.60	0.00	8.90	2.00	0.00
9	0.00	0.00	48.50	266.70	0.00	0.00	7.90	12.70	8.10	12.20	0.00	0.00
10	0.00	0.00	5.30	0.00	0.00	0.00	8.60	0.00	11.40	26.70	0.00	0.00
11	3.30	2.50	0.00	0.00	0.00	0.00	8.40	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	17.50	1.30	8.90	0.00	0.00	0.00	0.00
13	0.00	0.00	8.40	0.00	0.00	1.30	8.40	11.40	0.00	0.00	10.20	0.00
14	0.00	3.70	12.70	0.00	0.00	0.00	0.00	0.00	0.00	15.50	0.00	0.00
15	0.00	0.80	0.00	0.00	0.00	2.00	27.90	0.00	0.00	5.10	0.00	8.90
16	0.00	0.00	0.00	0.00	0.00	0.00	3.30	0.00	10.70	33.80	0.00	0.00
17	0.00	1.30	0.00	0.00	0.00	0.00	15.50	0.00	0.00	0.00	26.70	3.30
18	0.00	0.00	0.00	0.00	0.00	0.00	18.30	0.00	8.40	0.00	0.00	2.10
19	0.00	35.60	0.00	0.00	0.00	26.40	13.90	2.00	6.20	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	16.80	5.10	0.00	1.50	0.00	0.00
21	0.00	8.10	0.00	0.00	0.00	0.00	15.20	3.30	0.00	1.30	9.10	0.00
22	0.00	3.10	0.00	0.00	0.00	0.00	0.00	5.10	0.00	26.70	13.50	5.10
23	1.30	0.00	0.00	0.00	0.00	3.30	8.40	2.80	0.00	12.90	12.20	0.80
24	50.30	0.00	21.60	0.00	0.00	0.00	7.60	7.20	0.00	0.00	0.00	0.00
25	0.00	4.60	0.00	7.60	0.00	39.60	0.00	0.00	6.50	18.30	0.00	5.30
26	0.00	46.70	0.00	12.70	0.00	4.60	13.90	0.00	8.50	0.00	8.90	0.00
27	3.10	0.00	0.00	0.00	0.00	0.00	0.10	0.00	3.80	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	43.70	2.80	3.20	3.80	0.00	0.00
29	0.00	***	0.00	0.00	43.20	4.60	22.40	0.00	2.20	11.40	0.50	0.00
30	0.00	***	0.00	0.00	0.00	2.50	8.90	6.40	0.00	21.10	0.00	0.00
31	0.00	***	0.00	***	0.00	***	3.60	16.80	***	29.50	***	0.00
TOTAL	99.40	174.70	96.50	337.80	43.20	163.10	358.30	122.10	80.70	279.60	178.50	32.30
MEANS	3.21	4.45	3.11	11.26	1.39	5.44	11.56	3.94	2.69	9.02	4.28	1.04
S DEV	9.84	10.87	9.62	49.17	7.76	10.95	11.82	5.08	3.84	10.30	7.06	2.15

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1.00	10	11	5	4	1	12	25	17	12	19	11	7
12.00	2	3	3	3	1	5	12	3	0	12	4	0
25.00	1	2	1	2	1	3	3	0	0	4	1	0
50.00	1	0	0	2	0	0	0	0	0	0	0	0
100.00	0	0	0	1	0	0	0	0	0	0	0	0

TOTAL ANNUAL RAINFALL—— 1866.20 MILLIMETERS*
MEAN MONTHLY RAINFALL—— 155.52 MILLIMETERS*
STANDARD DEVIATION——— 109.80 MILLIMETERS*
*TOTAL ANNUAL RAINDAYS—— 134 DAYS
*MEAN MONTHLY RAINDAYS—— 11 DAYS
*STANDARD DEVIATION——— 7 DAYS

*COMPUTED FOR THE FIRST THRESHOLD ONLY.
MISSING DATA ARE CODED AS 999, THEY ARE NOT INCLUDED IN THE TOTAL.

PUBLISHED BY THE:
NATIONAL METEOROLOGICAL SERVICE
BELIZE INTERNATIONAL AIRPORT
P.O. BOX 717
BELIZE, CENTRAL AMERICA.

DAILY

RAINFALL (MILLIMETERS) AT CENTRAL FARM FOR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.00	7.60	2.00	0.00	0.00	0.00	0.00	0.00	0.00	22.60	999.00	999.00
2	0.00	0.00	3.30	0.00	0.00	0.00	16.50	1.30	0.00	3.30	999.00	999.00
3	0.00	13.50	0.00	1.30	0.00	37.10	10.20	0.00	0.00	16.80	999.00	999.00
4	0.00	18.50	0.00	6.40	0.00	0.00	4.30	0.00	8.60	3.80	999.00	999.00
5	0.00	5.30	0.00	0.00	0.00	0.00	1.50	8.10	0.00	0.00	999.00	999.00
6	0.00	0.00	0.00	0.00	0.00	0.00	51.10	5.40	0.00	8.60	999.00	999.00
7	0.00	0.40	0.00	0.00	0.00	0.00	6.10	1.30	5.10	10.70	999.00	999.00
8	0.00	2.80	0.00	0.00	11.40	0.00	17.80	1.30	11.40	0.00	999.00	999.00
9	0.00	0.00	9.70	0.00	0.00	0.00	1.00	0.00	12.20	0.00	999.00	999.00
10	0.00	20.30	0.00	0.00	0.00	1.30	10.20	0.00	9.70	0.00	999.00	999.00
11	0.00	0.00	0.00	0.00	0.00	21.10	0.00	0.00	0.00	8.90	999.00	999.00
12	0.00	0.00	0.00	0.00	0.00	13.90	0.00	4.60	0.00	13.90	999.00	999.00
13	12.70	0.00	0.00	0.00	0.00	38.40	0.00	5.30	5.80	0.00	999.00	999.00
14	11.20	0.00	3.60	0.00	0.00	0.00	10.20	0.00	0.00	5.60	999.00	999.00
15	22.40	0.00	0.00	0.00	10.70	24.90	3.10	1.50	0.00	0.00	999.00	999.00
16	0.00	0.00	0.00	0.00	2.30	34.30	0.00	5.30	12.90	0.00	999.00	999.00
17	0.00	0.00	0.00	0.00	0.00	1.80	0.00	11.20	1.30	0.00	999.00	999.00
18	2.50	0.00	0.00	0.00	0.00	1.50	0.00	12.90	0.00	0.00	999.00	999.00
19	23.60	4.30	0.00	0.00	0.00	0.70	6.10	17.30	1.50	0.00	999.00	999.00
20	1.30	0.00	0.00	0.00	0.00	6.40	0.00	7.90	3.80	0.00	999.00	999.00
21	19.10	0.00	0.00	0.00	0.00	12.20	2.00	3.10	0.00	0.00	999.00	999.00
22	17.80	0.00	0.00	0.00	0.00	13.90	3.30	1.80	0.00	0.00	999.00	999.00
23	0.00	0.00	0.00	0.00	0.00	0.00	21.30	7.60	0.00	0.00	999.00	999.00
24	0.00	0.00	0.00	0.00	2.80	0.00	16.00	0.00	0.00	0.00	999.00	999.00
25	0.00	0.00	0.00	0.00	1.80	0.00	6.10	0.00	6.40	6.40	999.00	999.00
26	0.00	0.00	0.00	0.00	2.50	6.40	8.40	1.30	4.10	6.40	999.00	999.00
27	0.00	0.00	0.00	0.00	0.00	0.00	24.20	3.80	12.70	30.70	999.00	999.00
28	0.00	0.00	0.00	0.00	6.90	0.00	53.90	2.80	0.00	19.10	999.00	999.00
29	0.00	0.00	0.00	0.00	20.30	0.00	33.80	0.00	0.00	26.70	999.00	999.00
30	0.00	***	0.00	0.00	6.40	0.00	13.90	5.30	43.70	8.60	999.00	999.00
31	0.00	***	0.00	***	3.80	***	7.70	0.00	***	8.90	***	999.00
TOTAL	110.60	72.70	18.60	7.70	68.90	213.90	330.70	110.10	139.20	201.00	0.00	0.00
MEANS	3.57	2.51	0.60	0.26	2.22	7.13	10.67	3.55	4.64	6.48	0.00	0.00
S DEV	7.39	5.56	1.92	1.18	4.58	12.02	14.03	4.39	8.66	8.68	0.00	0.00

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1.00	8	7	4	2	10	13	23	20	14	16	0	0
12.00	5	3	0	0	1	8	9	2	4	6	0	0
25.00	0	0	0	0	0	3	4	0	1	2	0	0
50.00	0	0	0	0	0	0	2	0	0	0	0	0
100.00	0	0	0	0	0	0	0	0	0	0	0	0

TOTAL ANNUAL RAINFALL---- 1273.40 MILLIMETERS
MEAN MONTHLY RAINFALL---- 106.12 MILLIMETERS
STANDARD DEVIATION------- 102.05 MILLIMETERS
*TOTAL ANNUAL RAINDAYS--- 117 DAYS
*MEAN MONTHLY RAINDAYS--- 10 DAYS
*STANDARD DEVIATION------ 8 DAYS
*COMPUTED FOR THE FIRST THRESHOLD ONLY.
MISSING DATA ARE CODED AS 999. THEY ARE NOT INCLUDED IN THE TOTAL.

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P.O. BOX 717
BELIZE, CENTRAL AMERICA.

DAILY RAINFALL (MILLIMETERS) AT CENTRAL FARM FOR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	999.00	0.00	1.30	0.00	0.00	5.60	0.00	0.00	0.00	1.80	0.00	0.30
2	999.00	9.70	0.30	23.10	0.00	5.30	0.00	0.00	0.00	55.40	100.10	0.80
3	999.00	0.00	0.00	0.00	0.00	0.80	2.00	0.00	0.00	7.40	0.50	1.80
4	999.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	18.00	7.40	4.30	8.40
5	999.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.50	0.00	3.60
6	999.00	0.00	3.60	0.00	1.50	0.00	0.00	0.00	0.00	0.50	0.00	1.30
7	0.00	0.00	8.90	0.00	6.10	0.00	1.80	0.00	14.70	0.00	5.30	7.90
8	0.00	0.00	13.00	0.00	0.00	0.00	7.10	0.00	1.00	1.80	0.00	7.40
9	0.00	0.00	3.10	1.30	0.00	1.30	0.00	0.00	0.50	16.80	25.40	1.50
10	0.00	0.00	1.80	0.00	0.00	0.80	2.80	0.00	7.10	0.00	2.30	9.40
11	0.00	5.30	0.30	0.00	0.00	0.00	0.50	0.00	3.30	0.00	15.50	0.80
12	0.00	0.00	0.00	0.00	0.00	17.80	35.10	0.00	7.60	0.50	6.90	0.00
13	0.00	0.00	0.00	0.00	0.00	4.60	10.70	0.00	23.10	0.80	25.70	0.00
14	0.00	0.50	0.00	19.30	0.00	1.30	8.40	0.00	1.30	0.50	20.10	19.10
15	0.00	6.10	0.00	3.80	0.00	0.00	0.00	0.00	10.40	35.60	4.30	9.90
16	0.00	0.00	0.00	0.00	0.00	3.80	0.00	0.00	0.00	9.10	12.20	9.70
17	0.00	17.80	999.00	1.30	0.00	5.80	0.50	10.20	10.70	1.80	3.10	0.00
18	0.00	33.00	999.00	0.00	0.00	1.00	7.90	0.50	1.30	14.20	4.30	0.00
19	0.00	39.60	9.10	0.00	0.00	0.00	8.60	0.00	5.80	3.10	0.00	23.90
20	0.80	35.60	0.00	0.00	0.00	0.00	999.00	10.20	0.80	0.50	0.00	0.30
21	3.30	45.70	0.00	0.00	0.00	0.00	1.00	46.00	1.80	15.20	0.00	2.30
22	9.10	0.00	0.00	0.00	0.00	0.00	0.00	18.80	0.50	0.00	4.80	7.10
23	0.00	0.00	0.00	0.00	0.00	3.30	0.00	3.10	27.90	0.50	0.00	0.00
24	0.00	34.00	0.00	0.00	0.00	2.50	0.80	0.30	0.50	6.40	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	10.40	1.30	0.00	0.00	1.30	0.00	0.00
26	0.00	1.00	0.00	0.00	0.00	4.30	0.00	21.80	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	2.50	36.10	0.00	2.50	0.00	0.00	1.50
28	0.00	1.50	0.00	0.00	0.00	3.80	5.10	2.50	8.40	0.00	0.00	0.00
29	0.00	***	0.00	0.00	0.00	39.90	0.00	3.60	4.10	0.00	0.80	0.00
30	0.00	***	0.00	0.00	0.80	0.30	0.00	12.20	0.30	0.00	0.00	0.00
31	0.00	***	0.00	***	4.80	***	3.60	0.00	***	0.00	***	0.00
TOTAL	13.20	229.80	41.40	48.80	13.20	114.10	134.10	129.70	152.60	181.10	235.60	117.00
MEANS	0.53	8.21	1.43	1.63	0.43	3.80	4.47	4.18	5.09	5.84	7.85	3.77
S DEV	1.91	14.61	3.27	5.40	1.38	7.65	9.04	9.64	7.32	11.90	18.97	5.89

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1.00	2	11	7	5	3	16	14	9	18	14	14	15
12.00	0	6	1	2	0	2	2	4	4	5	6	2
25.00	0	5	0	0	0	1	2	1	1	2	3	0
50.00	0	0	0	0	0	0	0	0	0	1	1	0
100.00	0	0	0	0	0	0	0	0	0	0	1	0

TOTAL ANNUAL RAINFALL---- 1410.60 MILLIMETERS
MEAN MONTHLY RAINFALL---- 117.55 MILLIMETERS
STANDARD DEVIATION------- 76.60 MILLIMETERS
*TOTAL ANNUAL RAINDAYS--- 128 DAYS
*MEAN MONTHLY RAINDAYS--- 11 DAYS
*STANDARD DEVIATION------ 5 DAYS

*COMPUTED FOR THE FIRST THRESHOLD ONLY.
MISSING DATA ARE CODED AS 999. THEY ARE NOT INCLUDED IN THE TOTAL.

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P.O. BOX 717
BELIZE, CENTRAL AMERICA.

DAILY RAINFALL (MM) AT CENTRAL FARM FOR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1.3	Ø.5	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	3.1	Ø.Ø	Ø.8	12.7	11.9	Ø.Ø
2	3.1	Ø.Ø	Ø.Ø	Ø.Ø	Ø.5	Ø.Ø	8.4	2.3	13.Ø	41.2	4.3	5.3
3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	3.6	5.3	1.8	9.9	Ø.8	4.8	Ø.Ø	Ø.Ø
4	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	5.3	1.8	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø
5	2.5	Ø.Ø	Ø.Ø	1.Ø	Ø.Ø	Ø.Ø	30.Ø	4.8	4.1	Ø.Ø	Ø.Ø	9.7
6	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.5	Ø.3	Ø.8	Ø.Ø	Ø.Ø	Ø.Ø
7	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.3	2.8	59.4	Ø.Ø	4.6	Ø.Ø	Ø.Ø
8	Ø.5	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	2.Ø	30.2	8.9	6.9	3.1	Ø.Ø
9	Ø.5	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	39.6	13.7	22.1	20.3	Ø.Ø	9.7	Ø.5
10	2.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.3	Ø.Ø	Ø.Ø	6.6	Ø.5	16.8	Ø.Ø
11	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	2.Ø	Ø.Ø	32.5	Ø.Ø	46.5	Ø.5
12	1.5	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	3.8	2.Ø	53.6	51.6	12.2	9.1	5.3
13	Ø.8	Ø.3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.8	4.3	Ø.Ø	3.6	1.5	2.Ø	6.9
14	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	25.1	Ø.Ø	17.5	3.1	34.Ø	7.9
15	1.8	1.8	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	14.2	Ø.Ø	7.9	12.5	9.7	2.3
16	3.8	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	8.6	11.4	Ø.Ø	46.2	Ø.5	4.1	Ø.8
17	1.3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	6.9	Ø.3	Ø.Ø	75.2	2.Ø	Ø.Ø	1.5
18	1.5	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.3	Ø.Ø	Ø.Ø	8.1	Ø.Ø	Ø.Ø	Ø.Ø
19	15.7	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.3	6.1	Ø.Ø	1.5	2.5	Ø.5	Ø.Ø
20	Ø.Ø	Ø.Ø	52.3	Ø.Ø	20.3	Ø.Ø	3.6	2.5	1.8	2.5	Ø.8	3.6
21	Ø.8	Ø.Ø	41.7	Ø.Ø	5.1	4.1	Ø.3	Ø.Ø	Ø.Ø	Ø.Ø	8.6	12.2
22	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	3.6	53.6	1.Ø	4.1	Ø.5	Ø.Ø	Ø.Ø
23	20.3	9.1	Ø.Ø	Ø.Ø	Ø.Ø	Ø.8	31.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø
24	11.4	Ø.Ø	Ø.Ø	Ø.Ø	9.9	18.Ø	Ø.Ø	1.3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø
25	Ø.Ø	Ø.Ø	7.6	Ø.Ø	37.9	17.8	Ø.Ø	Ø.3	Ø.3	Ø.Ø	Ø.Ø	Ø.Ø
26	6.6	Ø.Ø	22.1	Ø.Ø	18.3	6.1	Ø.Ø	Ø.8	18.Ø	Ø.Ø	Ø.Ø	Ø.8
27	Ø.Ø	Ø.Ø	15.2	Ø.Ø	4.8	Ø.3	1.3	Ø.8	4.6	Ø.Ø	3.6	Ø.Ø
28	Ø.Ø	Ø.Ø	1.Ø	Ø.Ø	25.4	16.Ø	Ø.Ø	Ø.3	1.Ø	2.Ø	Ø.Ø	Ø.Ø
29	2.3	***	5.1	Ø.Ø	105.2	9.4	Ø.Ø	8.6	Ø.Ø	13.7	Ø.Ø	Ø.Ø
30	22.9	***	Ø.Ø	Ø.Ø	5.6	3.3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø
31	2.3	***	Ø.Ø	***	Ø.Ø	***	Ø.Ø	Ø.5	***	5.1	***	Ø.Ø
TOTAL	102.9	11.7	145.Ø	1.Ø	236.6	147.6	222.8	200.5	329.2	128.8	164.7	57.3
MEANS	3.3	Ø.4	4.7	Ø.Ø	7.6	4.9	7.2	6.5	11.Ø	4.2	5.5	1.8
S DEV	5.9	1.7	12.2	Ø.2	19.9	8.3	12.Ø	14.7	17.7	8.Ø	10.4	3.2

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1	16	2	7	1	10	15	19	12	19	15	13	9
12	3	Ø	4	Ø	5	4	6	4	8	5	3	1
25	Ø	Ø	2	Ø	3	1	4	3	4	1	2	Ø
50	Ø	Ø	1	Ø	1	Ø	1	2	2	Ø	Ø	Ø
100	Ø	Ø	Ø	Ø	1	Ø	Ø	Ø	Ø	Ø	Ø	Ø

TOTAL ANNUAL RAINFALL------	1748.1 MM
MEAN MONTHLY RAINFALL------	145.7 MM
STANDARD DEVIATION---------	91.3 MM
*TOTAL ANNUAL RAINDAYS-----	138.Ø DAYS
*MEAN MONTHLY RAINDAYS-----	11.5 DAYS
*STANDARD DEVIATION--------	5.7 DAYS

*COMPUTED FOR THE FIRST THRESHOLD ONLY.
MISSING DATA ARE LEFT AS AN EMPTY SPACE

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R

DAILY RAINFALL (MM) AT CENTRAL FARM FOR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	4.6	Ø.Ø	1.Ø	Ø.Ø	Ø.Ø	5.3
2	Ø.Ø	Ø.Ø	8.9	Ø.Ø	Ø.Ø	Ø.Ø	4.1	22.9	Ø.Ø	Ø.Ø	Ø.Ø	3.8
3	Ø.Ø	Ø.Ø	7.9	Ø.Ø	Ø.Ø	1.3	9.1	6.9	Ø.5	11.4	Ø.Ø	Ø.Ø
4	Ø.Ø	Ø.Ø	47.5	Ø.Ø	Ø.Ø	13.Ø	4.8	11.2	8.6	1.5	Ø.8	Ø.Ø
5	Ø.Ø	Ø.Ø	2.5	Ø.Ø	Ø.Ø	7.1	2.3	1.8	Ø.3	Ø.Ø	Ø.3	Ø.Ø
6	Ø.Ø	9.1	Ø.Ø	Ø.Ø	Ø.Ø	22.1	14.2	Ø.Ø	Ø.3	Ø.Ø	Ø.5	Ø.Ø
7	Ø.Ø	5.6	Ø.Ø	Ø.Ø	Ø.Ø	20.1	4.3	Ø.Ø	1.5	Ø.Ø	Ø.Ø	Ø.Ø
8	5.3	Ø.3	Ø.Ø	Ø.Ø	Ø.Ø	31.8	Ø.5	15.2	57.2	Ø.Ø	Ø.Ø	Ø.Ø
9	Ø.Ø	Ø.Ø	Ø.Ø	14.Ø	Ø.Ø	5.3	9.4	Ø.Ø	14.2	Ø.3	Ø.Ø	Ø.Ø
1Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	21.8	39.6	Ø.Ø	7.9	12.7	Ø.8	Ø.Ø
11	1.3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.8	21.1	Ø.Ø	Ø.5	13.7	11.4	Ø.Ø
12	31.8	Ø.Ø	6.3	Ø.Ø	Ø.Ø	1.Ø	1Ø.4	Ø.Ø	7.6	Ø.Ø	Ø.Ø	Ø.Ø
13	1.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.5	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø
14	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.5	Ø.8	Ø.Ø	Ø.Ø	Ø.Ø
15	Ø.Ø	Ø.Ø	Ø.Ø	5.8	Ø.Ø	Ø.Ø	Ø.Ø	7.9	2.3	Ø.Ø	Ø.Ø	37.1
16	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.3	Ø.Ø	1.3	Ø.Ø	24.4
17	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	28.7	1.3	1.3	Ø.Ø	Ø.Ø	16.5	32.3
18	Ø.Ø	3.1	Ø.Ø	Ø.Ø	Ø.Ø	Ø.8	Ø.8	Ø.8	Ø.Ø	Ø.Ø	19.8	Ø.5
19	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.8	9.9	2.Ø	Ø.Ø	Ø.Ø	38.9	4.1
2Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	4Ø.6	11.4	Ø.Ø	25.4	Ø.Ø	4.8
21	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.5	2.3	Ø.3	5.1	Ø.8	1.Ø	39.6
22	1.3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.Ø	16.Ø	Ø.Ø	Ø.Ø	Ø.5	24.4
23	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	3.1	Ø.Ø	Ø.Ø	Ø.3	Ø.Ø	Ø.Ø	37.6	7.6
24	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	19.6	3.3	Ø.Ø	Ø.8	25.7	Ø.5
25	6.1	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	5.6	19.8	Ø.Ø	Ø.Ø	1.Ø	Ø.Ø
26	Ø.Ø	Ø.Ø	Ø.Ø	11.2	Ø.Ø	Ø.Ø	Ø.3	17.Ø	Ø.8	6.6	36.3	Ø.Ø
27	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	5.6	9.7	Ø.Ø	Ø.8	Ø.Ø	Ø.Ø
28	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	19.1	2Ø.3	11.9	Ø.Ø	6.1	Ø.Ø	1.5
29	Ø.Ø	***	Ø.Ø	Ø.Ø	Ø.Ø	13.2	9.7	Ø.Ø	Ø.Ø	Ø.Ø	Ø.3	1.Ø
3Ø	5.6	***	5.6	Ø.Ø	Ø.Ø	4.6	17.5	Ø.3	16.5	Ø.Ø	Ø.Ø	Ø.Ø
31	1.5	***	Ø.Ø	***	Ø.Ø	***	1.Ø	Ø.Ø	***	Ø.8	***	Ø.Ø
TOTAL	53.9	18.1	78.7	31.Ø	3.1	193.Ø	26Ø.4	161.8	125.1	82.2	191.4	186.9
MEANS	1.7	Ø.6	2.5	1.Ø	Ø.1	6.4	8.4	5.2	4.2	2.7	6.4	6.Ø
S DEV	5.7	2.Ø	8.6	3.3	Ø.5	9.6	1Ø.5	6.9	1Ø.7	5.7	12.2	11.6

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1	8	3	6	3	1	14	23	16	1Ø	8	9	12
12	1	Ø	1	1	Ø	8	7	5	3	3	6	5
25	1	Ø	1	Ø	Ø	2	2	Ø	1	1	4	3
5Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	Ø	Ø	Ø
1ØØ	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø

TOTAL ANNUAL RAINFALL------	1385.6 MM
MEAN MONTHLY RAINFALL------	115.5 MM
STANDARD DEVIATION---------	79.4 MM
*TOTAL ANNUAL RAINDAYS-----	113.Ø DAYS
*MEAN MONTHLY RAINDAYS-----	9.4 DAYS
*STANDARD DEVIATION--------	6.Ø DAYS

*COMPUTED FOR THE FIRST THRESHOLD ONLY.
MISSING DATA ARE LEFT AS AN EMPTY SPACE

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PHILIP S. W. GOLDSON
INTERNATIONAL AIRPORT
P.O. BOX 717
BELIZE. CENTRAL AMERICA.

DAILY RAINFALL (MM) AT BELMOPAN FOR 1986

1986 DEC | 1987 JAN

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	~~NOV~~	~~DEC~~
1	1.0	1.8	0.0	0.0		0.0	1.0	0.0	13.4	22.6	0.0	0.0
2	0.0	7.9	0.0	0.0		0.0	1.0	13.7	48.0	22.6	0.5	0.0
3	0.0	0.0	0.0	0.0		7.6	3.3	11.4	0.0	27.9	0.0	0.0
4	0.0	0.0	0.0	0.0		0.0	17.8	9.9	1.0	0.0	0.0	0.0
5	1.3	0.0	0.0	3.6		0.0	87.1	2.3	5.8		10.7	0.0
6	9.1	0.0	0.0	0.0		0.0	0.0	3.8	1.5		0.0	0.0
7	0.0	0.0	0.0	0.0		0.0	4.6	14.2	2.0	7.6	0.0	0.0
8	0.8	0.0	0.0	0.0		0.0	8.6	11.2	6.4	6.4	0.8	14.2
9	0.0	0.0	0.0	0.0		40.4	9.4	16.0	25.4	0.0	1.3	0.0
10	1.8	0.0	0.0	0.0		1.8	0.0	0.5	12.7	0.0	1.8	0.0
11	0.3	0.0	0.0	0.0		13.7	28.5	5.8	31.0	0.0	0.8	1.5
12	5.8	0.0	0.0	0.0		24.9	20.8	81.5	44.2	3.6	18.3	46.0
13	0.0	2.0	0.0	0.0		4.1	6.6	4.1	2.3	0.0	16.5	4.6
14	0.0	5.6	0.0	0.0		0.3	44.2	0.8	5.8	8.1	1.8	0.0
15	2.5	0.0	0.0	0.0		1.8	20.3	4.3	11.9	0.0	2.5	0.0
16	4.3	0.0	0.0	0.0		15.0	0.0	0.0	51.8	0.8	1.5	0.0
17	1.0	0.0	0.0	0.0		8.6	0.0	0.0	133.4	0.0	0.8	0.0
18	4.1	0.0	0.0	0.0		1.0	0.0	0.0	4.3	0.0	0.0	0.0
19	44.5	0.0	0.0	0.0		5.1	0.0	0.0	8.4	1.8	5.8	0.0
20	0.5	0.0	39.4	0.0		3.6	0.0	10.7	19.1	12.4		0.0
21	0.0	0.0	16.0			3.6	0.0	11.2	3.0	15.5		0.0
22	0.5	0.0	0.0			17.0	45.0	1.0	0.0	0.0		3.6
23	38.9	0.0	0.0			5.1	20.6	0.0	0.0	0.0		0.0
24	11.9	1.5	0.0			16.5	1.0	9.9	0.0	0.0	0.0	0.0
25	4.8	0.0	0.0			5.6	0.0	9.1	0.0	0.0	0.3	2.3
26	11.4	0.0	0.0			30.7	0.0	1.3	28.2	0.0	1.0	0.0
27	0.0	0.0	50.8			0.5	0.0	0.0	12.4	4.1	0.0	0.0
28	0.0	0.0	17.3			20.8	0.0	0.0	0.0	4.1	0.0	0.0
29	5.1	***	5.3			14.5	0.0	1.8	0.5	33.5	0.0	0.0
30	43.7	***	0.0			21.6	0.0	2.3	0.0	1.0	0.0	3.0
31	5.3	***	0.0			***	0.0	3.8	***	9.1	0.0	1.5
TOTAL	198.6	18.8	128.8	3.6		263.8	319.8	230.6	472.5	181.1	64.4	76.7
MEANS	6.4	0.7	4.2	0.2		8.8	10.3	7.4	15.8	6.2	2.5	2.5
S DEV	12.2	1.8	11.6	0.8		10.4	18.8	14.4	26.4	9.3	4.9	8.4

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1	17	5	5	1	21	16	21	22	15	10	8
12	3	0	4	0	10	8	4	11	6	2	2
25	3	0	2	0	2	4	1	7	2	0	1
50	0	0	1	0	0	1	1	2	0	0	0
100	0	0	0	0	0	0	0	1	0	0	0

TOTAL ANNUAL RAINFALL------	1958.7 MM
MEAN MONTHLY RAINFALL-------	178.1 MM
STANDARD DEVIATION----------	134.4 MM
*TOTAL ANNUAL RAINDAYS-----	141.0 DAYS
*MEAN MONTHLY RAINDAYS-----	12.8 DAYS
*STANDARD DEVIATION--------	7.0 DAYS

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BELIZE. CENTRAL AMERICA.

DAILY RAINFALL (MM) AT BELMOPAN FOR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	Ø.Ø	Ø.5	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	3.3		2.Ø	Ø.Ø	Ø.Ø	
2	Ø.Ø	Ø.Ø	4.6	Ø.Ø	Ø.Ø	2.Ø	10.2		Ø.Ø	Ø.Ø	Ø.Ø	2.Ø
3	Ø.Ø	Ø.Ø	4.8	Ø.Ø	Ø.Ø	Ø.Ø	55.9		20.6	21.8	Ø.Ø	Ø.Ø
4	Ø.Ø	Ø.Ø	37.3	Ø.Ø	Ø.Ø	1.3	7.1		Ø.8	Ø.Ø	1.3	Ø.Ø
5	Ø.Ø	Ø.Ø	Ø.8	Ø.Ø	Ø.Ø	4.3	3.6		17.5	Ø.Ø	2.8	Ø.Ø
6	Ø.Ø	7.6	Ø.Ø	Ø.Ø	Ø.Ø	63.5	41.7		4.1	Ø.Ø	Ø.Ø	Ø.Ø
7	Ø.Ø	1.Ø	Ø.Ø	2.3	Ø.Ø	27.2	8.9		1.5	2.Ø	Ø.Ø	Ø.Ø
8	14.2	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	26.7	3.1		37.8	Ø.8	Ø.Ø	Ø.Ø
9	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	32.8	11.2		39.4	1.Ø	Ø.Ø	Ø.Ø
10	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	12.2	63.3		Ø.5	4.3	7.9	Ø.Ø
11	1.5	Ø.Ø	Ø.Ø	Ø.3	Ø.Ø	1.8	26.9		3.6	25.7	1.5	Ø.Ø
12	46.Ø	Ø.Ø	27.4	2.3	Ø.Ø	Ø.3	8.4		64.5	Ø.Ø	Ø.Ø	Ø.Ø
13	4.6	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.Ø	2.Ø		Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø
14	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.3	Ø.5		Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø
15	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø		4.8	Ø.Ø	Ø.Ø	Ø.8
16	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.5	Ø.Ø		Ø.5	Ø.Ø	Ø.Ø	9.9
17	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	15.2	Ø.3		Ø.Ø	Ø.Ø	17.Ø	31.Ø
18	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	6.6	Ø.Ø		Ø.Ø	Ø.Ø	3.8	Ø.Ø
19	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.8	25.9		Ø.Ø	2.3	6.6	2.8
20	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.3	Ø.Ø	41.7		Ø.Ø	5.1	49.5	5.3
21	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	6.4	Ø.Ø	3.6		7.6	Ø.Ø	Ø.Ø	7.6
22	3.6	Ø.Ø	Ø.Ø	Ø.Ø	2.5	Ø.Ø	6.6		Ø.Ø	Ø.Ø	Ø.5	31.2
23	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	47.Ø	Ø.Ø	Ø.Ø		Ø.Ø	Ø.Ø	52.3	2.5
24	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	13.5		Ø.Ø	1.8	56.6	Ø.5
25	2.3	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	1.3		Ø.5	Ø.Ø	6.1	Ø.Ø
26	Ø.Ø	Ø.Ø	Ø.Ø	11.9	Ø.Ø	Ø.5	4.3		Ø.Ø	3.8	Ø.Ø	2.Ø
27	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	4.6		2.8	Ø.Ø	Ø.Ø	1.Ø
28	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	Ø.Ø	32.8	23.1		Ø.Ø	Ø.Ø	Ø.Ø	6.1
29	Ø.Ø	***	Ø.Ø	Ø.Ø	Ø.Ø	4.3	17.8		Ø.Ø	Ø.Ø	Ø.Ø	4.6
30	3.Ø	***	21.1	Ø.Ø	Ø.Ø	6.4	35.3		Ø.Ø	Ø.Ø	Ø.Ø	Ø.5
31	1.5	***	Ø.Ø	***	Ø.Ø	***	1.5		***	Ø.Ø	***	22.3
TOTAL	76.7	9.1	96.Ø	16.8	57.2	243.5	425.6		208.5	68.6	205.9	130.1
MEANS	2.5	Ø.3	3.1	Ø.6	1.8	8.1	13.7		7.Ø	2.2	6.9	4.3
S DEV	8.4	1.4	8.7	2.2	8.3	14.4	17.Ø		14.8	5.8	15.7	8.4

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1	8	2	5	3	4	18	25	12	9	11	13
12	2	Ø	3	Ø	1	7	1Ø	5	2	4	3
25	1	Ø	2	Ø	1	5	7	3	1	3	2
5Ø	Ø	Ø	Ø	Ø	Ø	1	2	1	Ø	2	Ø
1ØØ	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø

TOTAL ANNUAL RAINFALL------	1538.Ø MM
MEAN MONTHLY RAINFALL------	139.8 MM
STANDARD DEVIATION---------	117.4 MM
*TOTAL ANNUAL RAINDAYS-----	110.Ø DAYS
*MEAN MONTHLY RAINDAYS-----	10.Ø DAYS
*STANDARD DEVIATION--------	6.6 DAYS

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DAILY RAINFALL (MM) AT TOLEDO AGSTAT FOR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.00	0.00	0.00	6.40	0.00	0.00	24.10	145.80	0.00	15.00	0.00	0.00
2	0.00	17.50	2.50	0.00	0.00	0.00	17.80	34.80	78.00	41.40	0.00	46.50
3	0.00	0.00	0.00	0.00	0.00	62.00	23.60	69.10	1.30	5.60	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.30	17.00	0.00	0.00	11.70	0.00	36.60
5	0.00	12.20	0.00	0.00	0.00	23.40	3.00	1.00	0.00	6.30	22.60	0.00
6	0.00	0.50	20.60	0.00	0.00	0.00	44.50	20.30	2.80	3.80	18.00	4.10
7	0.00	2.50	0.00	0.00	0.00	0.30	108.00	0.00	8.10	0.00	0.80	4.10
8	0.00	5.10	2.50	0.00	35.80	3.30	64.80	21.10	42.70	0.30	0.00	0.00
9	0.00	10.70	0.00	0.00	0.00	34.30	6.40	0.00	59.70	0.00	0.00	0.00
10	0.00	11.70	12.70	0.00	21.10	20.10	33.80	42.70	5.80	0.00	0.00	0.30
11	0.00	0.00	0.00	0.00	2.50	15.20	2.00	21.10	32.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	34.80	49.50	3.80	2.00	30.70	1.00	28.50	0.00
13	24.60	0.00	7.10	0.00	21.10	204.70	0.00	0.00	35.30	6.30	3.60	0.00
14	35.30	14.70	0.00	30.70	19.30	2.50	3.30	13.00	3.80	0.00	1.00	125.70
15	0.30	0.00	0.00	0.00	58.90	17.80	1.00	0.00	0.00	0.00	0.00	12.70
16	3.60	0.00	0.00	0.00	27.70	33.00	0.00	0.00	89.90	16.30	7.90	3.10
17	0.00	4.10	0.00	0.00	120.10	117.30	1.30	5.60	80.00	4.30	11.20	11.40
18	1.30	0.00	1.30	0.00	5.30	14.70	4.60	0.00	51.10	9.40	0.00	15.50
19	46.70	22.90	0.00	0.00	0.00	14.20	5.60	24.60	16.80	26.70	0.00	14.70
20	0.00	0.00	0.00	0.00	0.00	37.80	12.20	11.90	17.30	0.00	1.80	2.30
21	20.60	0.00	0.00	0.00	0.30	0.00	57.70	53.80	34.50	0.00	5.60	3.80
22	10.20	0.50	0.00	0.00	0.00	30.70	11.40	4.10	0.00	1.80	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	5.60	0.00	0.00	56.90	5.30	0.00	11.40
24	0.00	0.00	0.00	0.00	53.30	74.70	34.30	0.00	2.80	1.00	0.00	33.80
25	0.00	0.00	0.00	0.00	53.10	1.30	2.00	0.00	34.00	0.00	0.00	14.00
26	5.10	0.00	0.00	0.00	87.40	8.40	20.10	131.30	1.50	11.70	0.00	12.70
27	0.80	0.00	0.00	0.00	5.10	2.30	21.10	29.00	9.90	0.00	0.00	16.00
28	6.90	0.00	0.00	0.00	4.10	2.00	0.00	0.00	0.00	94.00	0.00	35.80
29	9.70	0.00	0.00	0.00	0.00	0.80	32.00	32.80	0.00	4.60	0.00	2.80
30	0.50	***	0.00	0.00	23.40	52.80	0.30	0.30	13.00	2.50	0.00	0.00
31	0.00	***	0.00	***	1.50	***	16.30	36.30	***	14.00	***	0.00
TOTAL	165.60	102.40	46.70	37.10	574.80	829.00	572.00	700.60	707.90	283.00	101.00	409.30
MEANS	5.34	3.53	1.51	1.24	18.54	27.63	18.45	22.60	23.60	9.13	3.37	13.20
S DEV	11.34	6.37	4.40	5.69	29.26	43.19	23.97	36.00	27.32	18.20	7.30	24.46

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

1.00	10	9	6	2	17	23	26	19	23	20	9	19
12.00	4	4	2	1	12	16	15	14	15	6	3	11
25.00	2	0	0	1	8	10	7	9	12	3	1	5
50.00	0	0	0	0	5	5	3	4	6	1	0	1
100.00	0	0	0	0	1	2	1	2	0	0	0	1

TOTAL ANNUAL RAINFALL——	4529.40	MM
MEAN MONTHLY RAINFALL——	377.45	MM
STANDARD DEVIATION———	290.21	MM
*TOTAL ANNUAL RAINDAYS---	183	DAYS
*MEAN MONTHLY RAINDAYS——	15	DAYS
*STANDARD DEVIATION———	8	DAYS

*COMPUTED FOR THE FIRST THRESHOLD ONLY.
MISSING DATA ARE CODED AS 999. THEY ARE NOT INCLUDED IN THE TOTAL.

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DAILY RAINFALL (INCHES) AT PUNTA GORDA FOR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.91	0.00	0.00	0.00	0.00	2.58	0.20	0.00	2.93	0.00	0.00	0.13
2	0.00	0.00	0.00	1.69	0.00	2.85	1.63	1.07	1.42	0.35	0.00	0.03
3	0.00	0.09	0.00	0.00	0.00	0.19	1.11	0.50	0.37	3.92	0.95	0.25
4	0.00	0.04	0.00	0.00	0.00	0.00	0.00	1.22	0.35	0.00	0.03	0.06
5	0.00	0.00	0.00	0.00	0.77	0.08	0.00	0.09	0.00	0.63	0.00	0.14
6	0.08	0.00	0.54	0.00	1.00	0.00	0.00	1.28	0.00	0.00	0.00	0.35
7	0.00	0.00	0.90	0.00	0.31	0.00	0.79	0.12	2.26	0.00	1.72	0.11
8	0.00	0.00	0.83	0.50	0.04	0.00	0.45	0.47	0.03	0.00	0.00	0.67
9	0.00	0.04	0.15	0.86	0.20	1.78	0.53	0.02	0.00	0.22	0.23	0.07
10	0.20	0.00	0.03	0.00	0.00	1.12	0.13	0.00	0.00	0.03	2.00	0.06
11	0.00	0.00	0.11	0.00	0.00	0.18	0.16	0.39	0.18	0.15	0.96	0.14
12	0.00	0.03	0.00	0.64	0.00	0.00	0.86	0.00	1.02	0.00	0.06	0.00
13	0.40	0.06	0.00	0.00	0.00	0.94	0.01	0.07	0.86	0.44	1.07	0.00
14	0.00	0.25	0.00	0.19	0.00	0.00	0.00	2.16	0.14	2.74	0.11	0.50
15	0.07	1.15	0.00	0.47	0.00	0.58	2.47	0.00	0.00	5.13	0.47	0.03
16	0.00	0.05	0.00	0.00	0.00	0.05	0.49	0.29	0.06	1.63	0.70	0.00
17	0.00	0.04	0.00	0.21	0.00	5.52	1.17	0.10	0.46	0.90	0.34	0.00
18	0.00	0.40	0.46	0.43	0.13	0.13	2.16	4.37	0.03	1.65	0.61	0.20
19	0.00	1.80	0.08	0.03	0.00	0.11	1.20	0.07	0.93	0.00	0.04	0.60
20	0.00	0.84	0.00	0.00	0.00	0.00	2.87	1.79	0.00	0.00	0.00	0.03
21	1.29	0.14	0.00	0.00	0.00	0.08	1.59	1.03	0.55	0.30	0.00	0.29
22	0.87	0.02	0.00	0.00	0.00	0.06	0.31	0.21	0.00	0.00	0.81	0.06
23	1.41	0.00	0.00	0.00	0.11	4.43	0.14	0.67	1.74	0.00	0.00	0.00
24	0.00	0.17	0.00	0.00	0.00	3.75	0.03	0.05	0.04	0.00	0.05	0.00
25	0.00	0.27	0.02	0.00	0.00	0.56	2.47	1.40	0.00	0.00	1.12	0.32
26	0.00	0.08	0.00	0.00	0.00	0.89	0.24	1.27	0.35	0.00	0.03	0.00
27	0.00	0.00	0.27	0.00	0.00	0.77	0.00	3.63	0.46	0.00	0.00	0.00
28	0.00	0.68	0.00	0.00	0.00	0.58	1.16	1.33	0.00	0.00	0.07	0.00
29	0.22	***	0.00	0.00	0.02	5.42	0.06	0.11	0.00	0.00	0.00	0.25
30	0.00	***	0.00	0.13	1.30	0.18	0.08	1.62	0.25	0.00	0.00	0.00
31	0.00	***	0.00	***	0.42	***	1.14	0.00	***	0.15	***	0.03
TOTAL	5.45	6.15	3.39	5.15	4.30	32.83	23.45	25.33	14.43	18.24	11.37	4.32
MEANS	0.18	0.22	0.11	0.17	0.14	1.09	0.76	0.82	0.48	0.59	0.38	0.14
S DEV	0.39	0.42	0.24	0.37	0.32	1.66	0.85	1.06	0.74	1.23	0.55	0.18

RAINDAYS FOR 5 DEFINED RAINFALL THRESHOLDS.

0.04	9	16	8	9	9	23	24	25	18	13	17	17
0.50	4	4	3	4	3	14	14	14	8	7	9	3
1.00	2	2	0	1	2	8	11	12	5	5	4	0
2.00	0	0	0	0	0	6	4	3	2	3	1	0
4.00	0	0	0	0	0	3	0	1	0	1	0	0

TOTAL ANNUAL RAINFALL----	154.41	INCHES
MEAN MONTHLY RAINFALL----	12.87	INCHES
STANDARD DEVIATION-------	9.98	INCHES
*TOTAL ANNUAL RAINDAYS---	188	DAYS
*MEAN MONTHLY RAINDAYS---	16	DAYS
*STANDARD DEVIATION------	6	DAYS

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*COMPUTED FOR THE FIRST THRESHOLD ONLY.
MISSING DATA ARE CODED AS 999. THEY ARE NOT INCLUDED IN THE TOTAL.

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AVERAGE TEMPERATURE FOR CENTRAL FARM (CAYO)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
JANUARY	72	73	75			74	73	72	71	73	76	78	76	75	75	71	72	71	73	
FEBRUARY	78	73	72			76	73	73	73	75	74	74	78	77	76	74	76	75	75	73
MARCH	77	75	78		76	79	75	77	75	77	79	78	78	79	79	77	74	79	77	76
APRIL	81	77	80	79	79	80	75	77	79	82	79	79	81	83	83	79	77	77	81	79
MAY	79	81	81	86	83	84	81	81	83	84	86	83	81	86	83	81	80	81	83	82
JUNE	83	79	83	83	83	85	80	81	81	81	81	82	83	82	81	NA	80	82	82	78
JULY	79	77	80	87	80	82	80	80	80	81	81	81	81	80	80	NA	80	81	81	
AUGUST	81	79	79	82	80	82	79	81	81	81	83	81	81	82	81	81	81	81	81	
SEPTEMBER	81	81	80	81	81	NA	81	80	80	83	81	81	83	81	80	79	82	81		
OCTOBER	79	79	79		78		79	79	80	80	80	81	80	79	80	80	79	78	79	
NOVEMBER	71	77	78		76		75	77	78	75	77	76	78	80	NA	77	77	77	77	
DECEMBER	73	76	75		75	73	73	75	77	74	72	76	74	78	NA	75	76	75	73	

R

AVERAGE TEMPERATURES FOR BELMOPAN

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
JANUARY							68	71	72	73	77	70	73	73	72		70	71	73	73
FEBRUARY							70	73	72	74		72	74	74	74	74	74	75	74	71
MARCH					76		75	75	76	77			77	77	76	76	74	78	76	74
APRIL					79		77	79	79	81			80	80	80	77	75	77	80	78
MAY					81		82	81	81	82			83	83	80	80		81	83	80
JUNE					81		79	81	81	80		80	83	83	80	80	80	82	83	80
JULY							79	79	79	80		79			79	79	79	81	81	
AUGUST							79	81	80			79	81	81			80		81	
SEPTEMBER					82		79	81	80			80	80	80	80	79	79	81	80	
OCTOBER							79	79	79	79	80	79	79	79	79	78	78	78	78	
NOVEMBER							75	75	77	77	76	75	75	77	77	73	76	77	76	75
DECEMBER							71	73	75	76	75	72	73	75	75	73	73	75	74	73

10 YEAR AVERAGE: CLIMATIC DATA FOR PUNTA GORDA

Climatic Data ... 10 year average

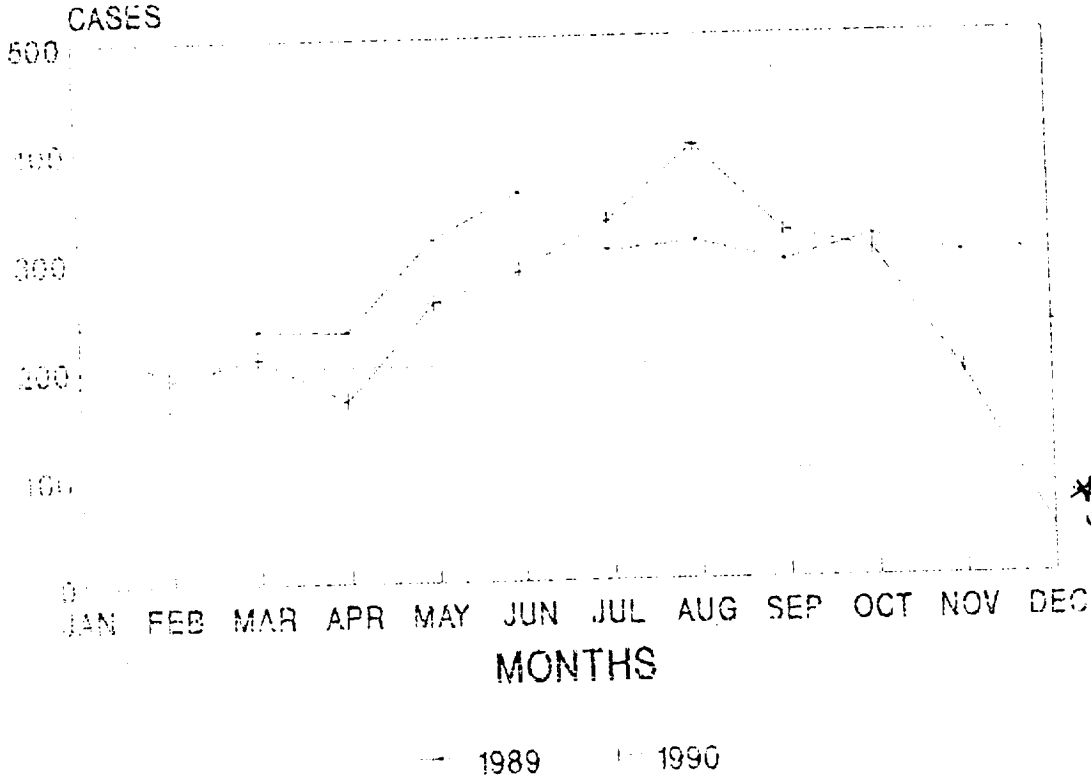
... for 1966 to 1977

	J	F	M	A	M	J	J	A	S	O	N	D
...Temp (°F)	72	73	75	77	79	79	79	78	78	77	74	72
...(°F) ...Temp	81	83	86	87	88	87	86	86	86	86	83	80
...minimum	63	63	65	66	69	71	71	70	70	69	66	64
...imum Temp.	92	[illegible]	97	103	98	98	95	94	93	105	92	94
...inimum Temp	41	50	51	51	56	55	57	52	56	50	42	48
...hes)	8.7	4.99	3.73	3.72	9.16	23.91	27.80	25.14	21.91	13.71	9.84	8.77
...	14	9	7	6	11	20	23	23	21	17	15	13
... Hours	48	52	61	55	56	40	46	62	43	43	47	44
...umidity (%)	87	83	85	86	85	88	88	85	87	88	87	88

Annex 4. 1990 Malaria Information from the National Malaria Service

1. Cases of malaria: Belize 1989-1990
2. Cases by parasite species: Belize 1990
3. Malaria cases-Belize: by age and district 1989
4. The ten most positive localities (Cayo District, Dec. 1990)
5. Malaria incidence rate: Belize 1989
6. House spraying rate per 1000 houses
7. Mosquito species collected in Belize: Feb.-Mar. 1982

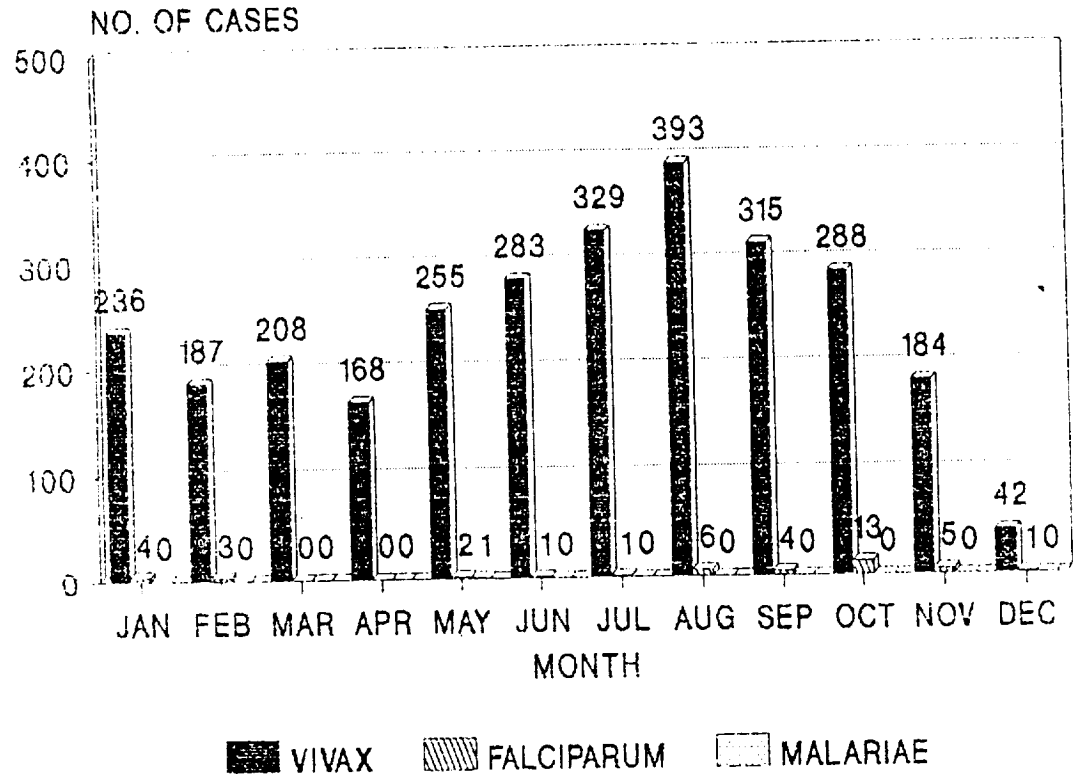
CASES OF MALARIA
BELIZE 1989-1990



* incomplete

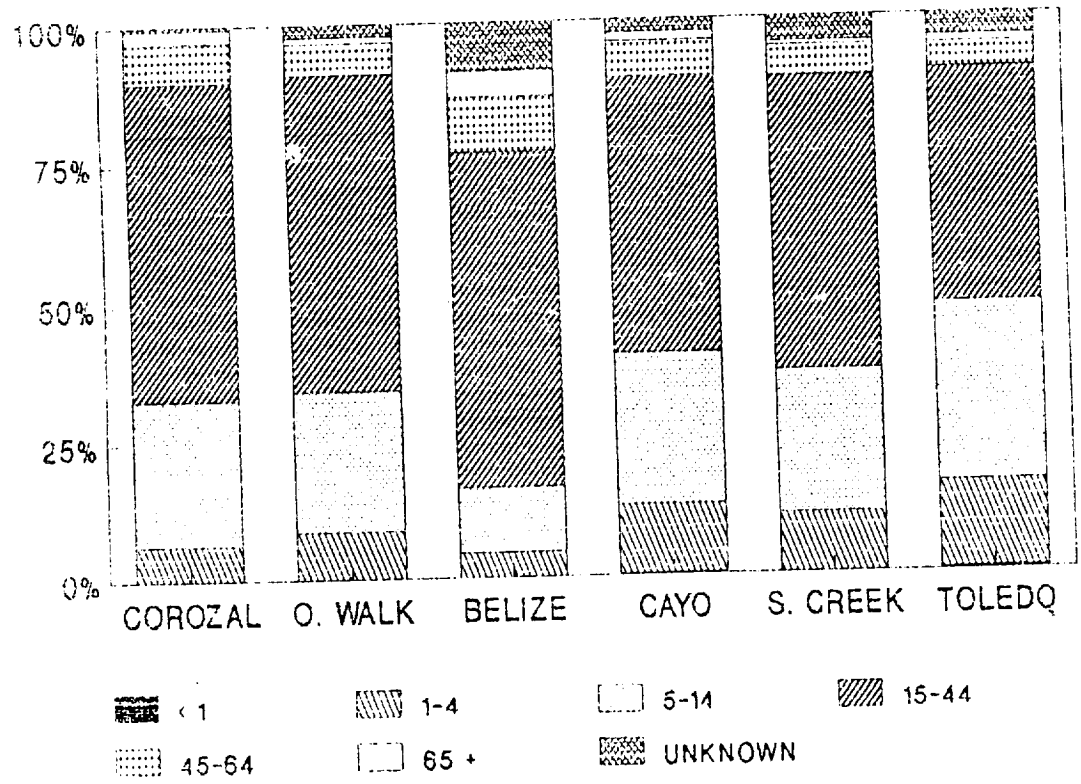
SOURCE: MEDICAL STATISTICS OFFICE

CASES BY PARASITE SPECIE
BELIZE 1990



SOURCE: MEDICAL STATISTICS OFFICE

MALARIA CASES - BELIZE
BY AGE AND DISTRICT 1989



SOURCE: MEDICAL STATISTICS OFFICE

THE TEN MOST POSITIVE LOCALITIES
CAYO DISTRICT, DECEMBER 1990

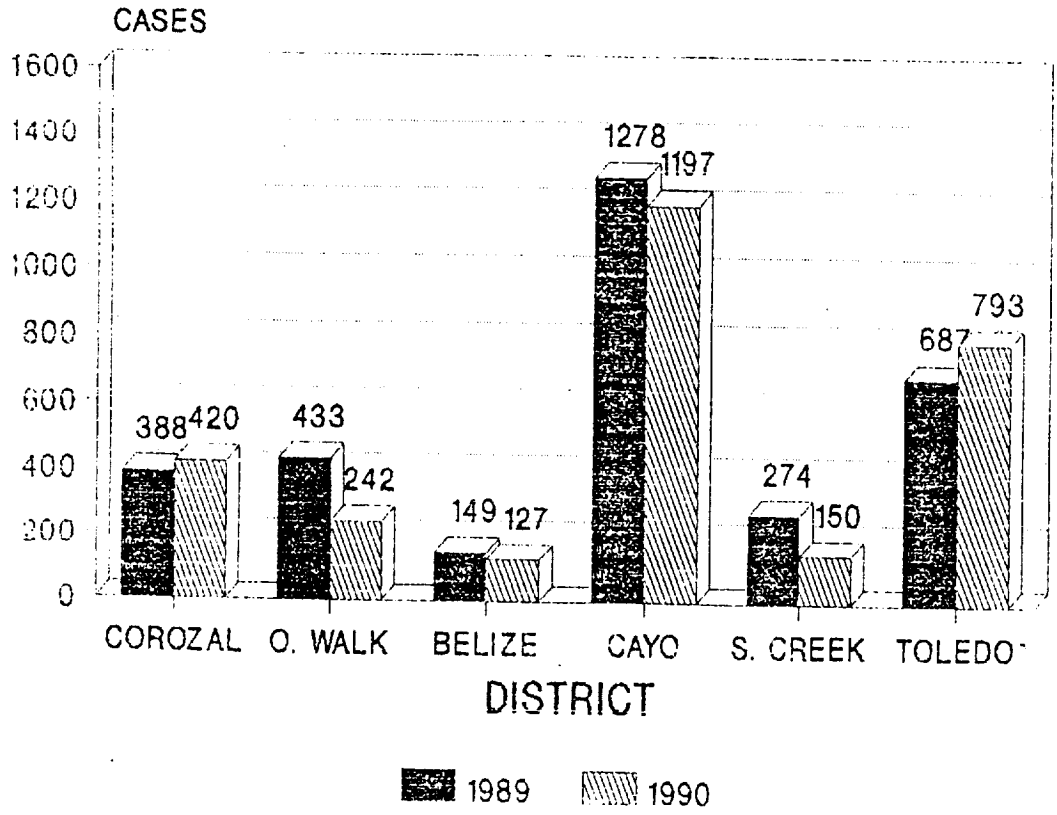
Localities	Cases		
	Vivax	Falcip.	Total
1. Las Flores	163	3	166
2. Belmopan	108	-	108
3. Over the top	87	-	87
4 Roaring River	50	16	66
5. Benque Viejo	62	3	65
6. Valley of Peace	60	1	61
7. San Ignacio	49	-	49
8. Belmopan Cooper.	46	-	46
9. Camalote	43	-	43
10. Teakettle	42	-	42

Of the 114 localities in the Cayo District 62 are positive which corresponds to 54.3%

This year we have had 22 cases of Malaria on patients from Melchor de Mencos. Apparently the complaint has been fever for which they consult the Health Center at Benque Viejo.

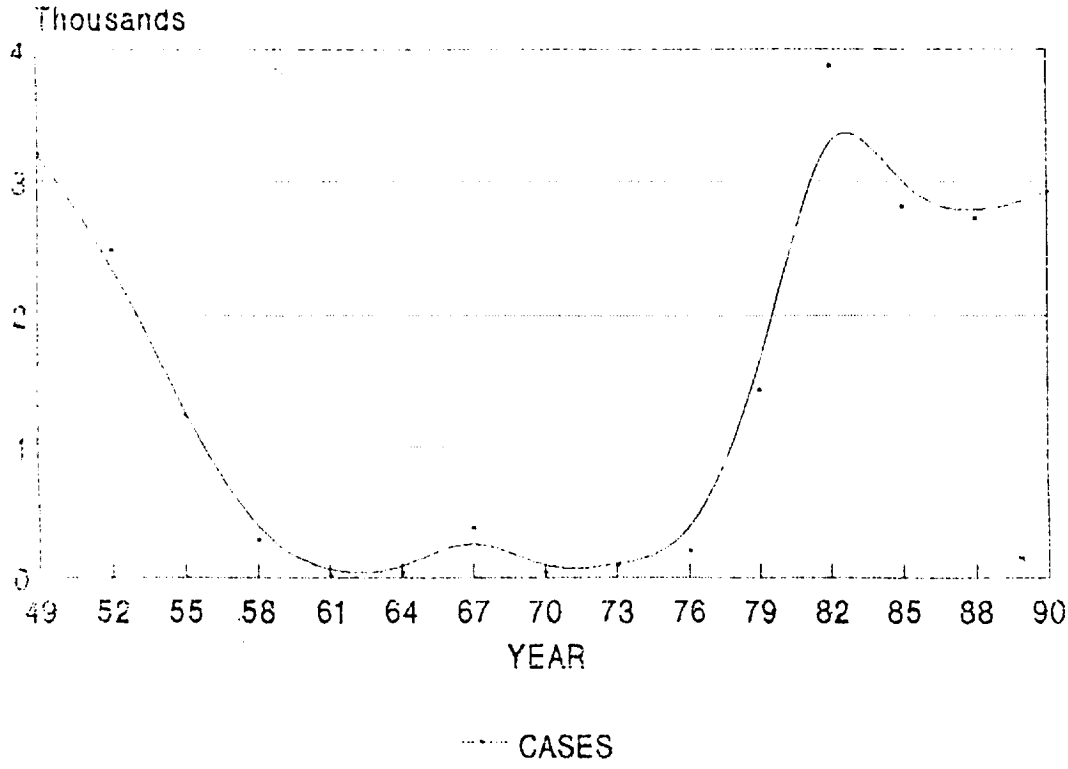
MALARIA CASES BY DISTRICTS

BELIZE 1989 - 1990 (MAY.)



SOURCE: MEDICAL STATISTICS OFFICE

TREND OF MALARIA - BELIZE
1949 - 1990



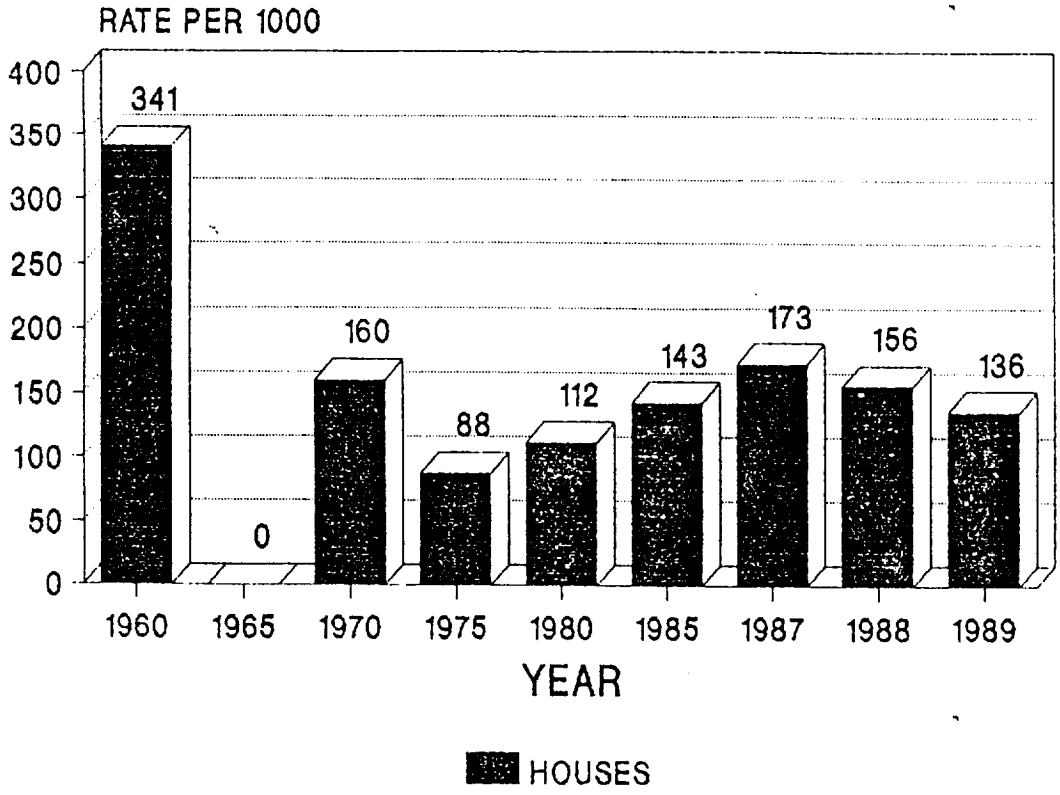
SOURCE: MEDICAL STATISTICS OFFICE

MOSQUITO SPECIES COLLECTED IN BELIZE
FEB. - MAR. 1982

SPECIES	LOCATION
Anopheles crucians	Airport Camp
Anopheles albimanus	Airport Camp
Anopheles apicimacula	Piedra village (Moho River)
	Ferry point (Temash River)
	San Felipe village (Toledo)
	Baranco village (Toledo)
Mansonia indubitans	Altun Ha
Mansonia pseudotitillans	Airport Camp
Mansonia nigricans	Piedra village (Moho River)
	Ferry point (Temash River)
	Baranco village
Aedes taeniorhychus	Altun Ha
Aedes angustivittatus	Piedra village (Moho River)
Psorophora albipes	Ferry point (Temash River)
Psorophora ferox	Ferry point (Temash River)

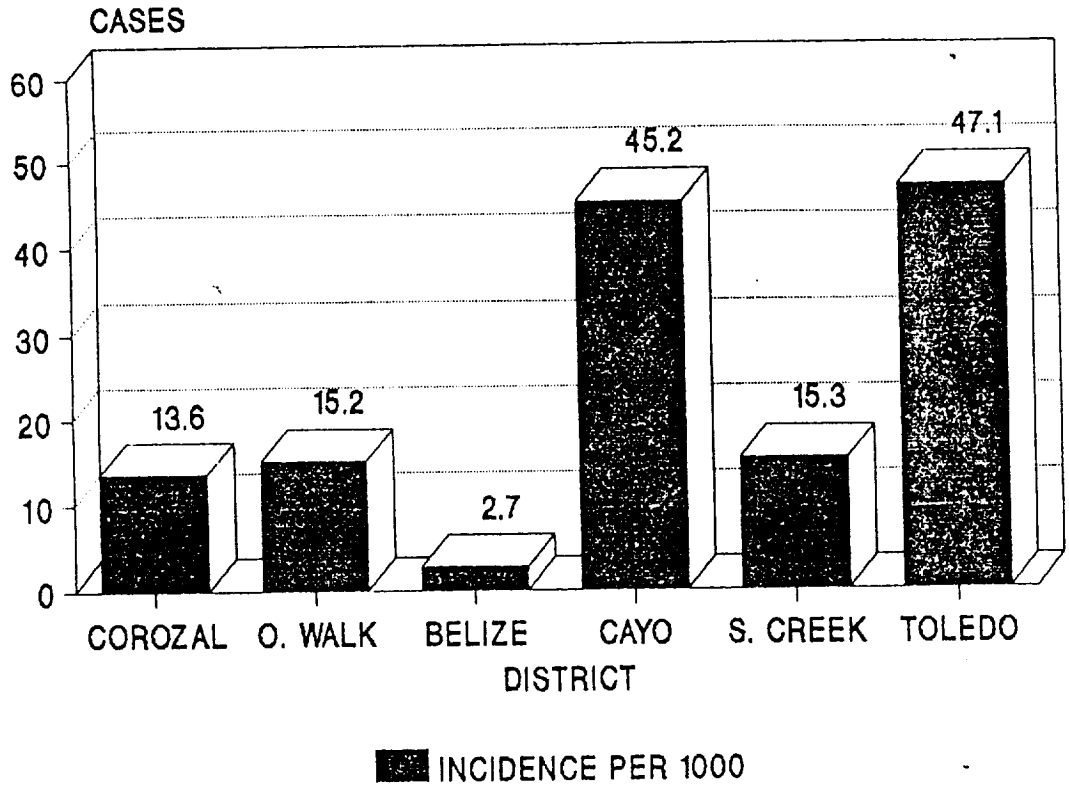
HOUSE SPRAYING RATE

PER 1000 HOUSES



SOURCE: MALARIA OFFICE

MALARIA INCIDENCE RATE
BELIZE 1989



SOURCE: MEDICAL STATISTICS OFFICE